THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXVII.—*The Aurora, viewed as an Electric Discharge between the Magnetic Poles of the Earth, modified by the Earth's Magnetism;* by BENJAMIN V. MARSH. With two plates.

IT was shown by Dalton that the appearances presented by the Aurora could be explained by supposing the existence of *horizontal bands* of luminous matter nearly at right angles to the magnetic meridian, and of *columns parallel to the dipping needle*, —the former constituting the auroral "arch,"and the latter the "streamers"—and he suspected that the streamers either stood upon the arch, or depended from it.

Subsequent observations have confirmed the reality of these bands and columns, and have shown that, ordinarily, *the streamers stand upon the arch as a base.* When the arch is nearly overhead we see the streamers through it, as through a curtain, and have no means of determining which is the more distant, both being in the same direction from the eye. But when, as more frequently happens, the whole display lies far to the north of us we can observe clearly the relative position of the parts. We then see an arch stretching over the northern horizon, with streamers standing upon the arch and not extending below it. The tops of the streamers may be at very unequal elevations but their bases will generally be found arranged in the regular curve of the arch—although when there are two concentric arches the streamers from the lower may appear to extend into the upper and thus render the phenomenon more complicated.

The auroral arch as seen over the northern horizon is generally a perfect and regular arc of a circle, its highest point being

nearly on the magnetic meridian and its extremities resting upon the horizon. This being true in all longitudes where observations have been made, it necessarily follows that the arch is always part of a circle, the centre (or rather the pole) of which corresponds very nearly to the magnetic pole of the earth.

In the great display of August 28th, 1859, the arches seemed to centre in the northeast as seen from California, nearly in the north from Philadelphia, and in the northwest as seen from England. So that there is great reason to suppose they were *rings, more or less perfect surrounding the north magnetic pole, and parallel to the surface of the earth beneath them.*

In the Journal of the Franklin Institute for November, 1859, I gave what appeared to me satisfactory evidence that on that occasion at half past 9 P. M. the most southern of these rings was about 300 miles wide (its northern margin being vertical over Newburyport, Mass., and its southern over Frederick, Maryland), and that it was about 43 miles from the earth—also that streamers near 580 miles in length and several miles in diameter, springing from this ring as a base, extended to a height of near 600 miles from the earth, the tops of the most southern streamers being vertical over Norfolk and being distinctly visible from Havana where they extended 23 degrees above the northern horizon. These streamers had a rapid but steady motion from *east to west*, that is they *revolved around the north magnetic pole of the earth in that direction.*

In this case then the lowest part of the auroral display being more than forty miles from the surface of the earth, where the rarity of the air must be fully equal to that attainable with the best air-pump, and the highest, extending far beyond what is ordinarily supposed to be the extreme limit of the atmosphere, it must be very difficult to imitate the whole phenomenon experimentally even if the subject were fully understood. But I desire to call attention to the very striking agreement between some of the essential features of the aurora, and phenomena observed by Plücker and Gassiot in their recent investigations in reference to the electric discharge in vacuo.

Prof. Plücker of Bonn, in a series of experiments on "the action exerted by a magnet on the luminous electric discharge passing through a tube or other glass vessel which contains residual traces of any gas or vapor," by passing the discharge from an induction coil through large Torricellian vacuum-tubes "of a cylindrical shape into which long wires enter from both ends," has succeeded in showing that the electric light passing from the negative wire towards the positive is "bent by the magnet into curves and surfaces."

He says (Proceedings of Royal Society, vol. x, No. 38, p. 258) "The magnet acts on this light in a peculiar way, having no analogy with phenomena hitherto observed. I easily discovered the law giving in all cases the exact description of the phenome-

non. The light emanating from any not isolated point of the negative wire and diverging in all directions towards the interior surface of the surrounding tube *is bent by the action of the magnet into the magnetic curve which passes through this point.*"

"Such a curve is the only one along which an electric current can move without being disturbed by the magnet. It equally represents the form which a chain of infinitely small iron needles absolutely flexible, and not subjected to gravity, would assume if attached with one of its points on the point of the negative wire. It is well known that a magnetic curve is completely determined by one of its points. Therefore the whole light starting from all the different points of the negative wire *will be concentrated within a surface generated by a variable magnetic curve.*"

"The negative light partly depends upon the substance of the wire. Particles of it, either pure or combined with the included gas, are carried off to the interior surface of the tube, which when platina wires are used, consequently is blackened. If not acted upon by the magnet all the parts of the surface surrounding the platina wire become black; *if acted upon, only that line along which the surface of the tube is intersected by the magnetic surface is blackened. In this case therefore the particles separated from the wire move along magnetic curves.*"

"The importance of the use of magnetic curves or lines of magnetic force, in experimental researches, has been shown by several philosophers, especially Mr. Faraday. Hitherto only filings of iron enabled us to give, in peculiar cases, an imperfect image of these curves. *We may now trace through space such a curve in the most distinct way and illuminate it with bright electric light.*"

Dr. J. Baker Edwards, who subsequently made somewhat similar experiments, in speaking of the light of the electric discharge through an exhausted tube, says, (Proceedings of Literary and Philosophical Society of Liverpool, No. 14, 1859, 1860, p. 134), "When this column of light is made to fall over the pole of an electro-magnet it is attracted in the direction of the magnetic curves and *rotates rapidly around the magnet*, the direction of its motion being reversed when the polarity is altered or the direction of the current is changed."*

Now if in these experiments we suppose the electro-magnet to represent the magnetism of the earth—the negative wire the auroral "arch"—and the lines of magnetic light the auroral "streamers," are not the phenomena absolutely identical?

* On page 631 of the second edition of Silliman's Physics, recently published and which I had not seen when the above was written, is a figure and description of Geissler's form of an apparatus first contrived by De la Rive to exhibit this rotation. Prof. S. says, "if an electro-magnet is enclosed in the electrical egg, and a very perfect vacuum is made within it, when the induction current is caused to flow, *the electrical stream is seen to revolve in a steady and easy manner about the magnet, the direction of its motion corresponding to the polarity of the magnet.*

In an aurora the centre of the corona being the vanishing point of the nearly parallel streamers which compose it, it is evident that a streamer having its base exactly in this centre (as *a b* or *c d*, fig. 1, Plate V,) must be seen absolutely endwise, and must appear merely as a bright spot in the centre of the corona—the line drawn from the base of this streamer to the eye of the observer (at A, or B, fig. 1) being a continuation of its axis. But it is found that this line always coincides with the direction of the axis of the dipping needle, at whatever place the observation is made, and, since the position of the dipping needle at any point on the surface of the earth is such that its axis lies in the magnetic curve passing through that point, it necessarily follows that the axis of the streamer in question must lie in a continuation of this magnetic curve, which for so short a distance may be treated as a straight line. Hence we must conclude *that every auroral streamer lies wholly in the magnetic curve which passes through its base.*

But an electric discharge from the parts of the atmosphere overlying the vicinity of the north magnetic pole, in passing toward the south magnetic pole, would, according to the law of Prof. Plücker, be compelled by the magnetism of the earth, to move along the magnetic curve passing throu[illegible] the point from which it starts. Hence as we find the auroral streamers occupying this very curve, presenting every appearance of streams of electricity, and revolving around the magnetic pole of the earth, just as Dr. Edwards observed the electric streams to do around the pole of the magnet, we seem justified in concluding that they really are *currents of electricity passing from the auroral arch on their way to the south magnetic pole, or perhaps to a corresponding arch surrounding it.* (See fig. 1, Plate V.)

If so it will probably be found that the phenomena in the two hemispheres, although simultaneous, are not identical, just as the appearances in the electric discharge in vacuo are widely different at the positive and negative terminals.

It is true that we have succeeded in tracing the streamers only five or six hundred miles, out of the many thousands they must traverse to reach their destination in the southern hemisphere, but their illumination even thus far beyond the supposed limits of the atmosphere is probably due in part to particles of matter carried from the arch, just as portions of the platinum wire were conveyed by the currents to the surface of the glass in the experiments of Prof. Plücker—and the invisibility of the streamers beyond this point may result from their great distance from the observer combined with the greater diffusion of the current and the absence of matter to be illuminated.*

* The experiment of Prof. Plücker shows that electric currents have a powerful tendency to transport portions of the electrode, the cohesion of even so hard a sub-

Whatever may be the material constituting the auroral arch, it does not seem capable of penetrating the denser portions of the atmosphere but rather glides over them with a horizontal motion. Its observed form and motions may perhaps be most readily explained by supposing it to originate as a horizontal stratum of cloud, of a circular form, having its centre vertical over the north magnetic pole. Such a cloud, if repelled by this pole and attracted by the south magnetic pole, must, in commencing its motion southward (if there be any coherence between its parts) be converted into a ring, which would glide over the upper surface of the atmosphere, its diameter constantly increasing, like that of a circular ripple in water, as it moved towards the magnetic equator. In this case the ring itself would always occupy the position of a magnetic parallel of latitude; and the part of it visible from any place on the surface of the earth would appear as an arch with its ends resting upon the horizon and with its highest point on the magnetic meridian. Other similar clouds successively formed over the pole and then impelled southward would present the same phases, and when they were sufficiently near to each other, an observer would see several concentric arches, as is the case in some auroral displays.

The material composing the arch seems, in the steadiness and mildness of its light, its rolling motion, and cloudy appearance, strikingly to resemble the "glow" which is frequently seen in electric discharges in vacuo and which is very remarkable in some forms of the "stratified discharge." In the "Proceedings of the Royal Society," vol. x, Nos. 38 and 39, Mr. J. P. Gassiot, in giving the results of numerous experiments upon the electric discharge through his carbonic acid vacuum tubes, describes many varieties of the "stratified discharge." In some instances several luminous cloud-like concentric envelopes sur-

stance as platinum being insufficient to resist it; and the great height to which auroral streamers are seen to extend renders it probable that their visibility is due to matter so transported from the auroral arch—and since they are illuminated instantaneously throughout their whole length, *the velocity of the particles of matter carried up must approximate to that of electricity itself.*

The auroral columns shooting up instantaneously to such immense heights and maintaining their rectilinear form while revolving, as they frequently do, with great angular velocity around the magnetic axis of the earth are strikingly analogous to the tails of comets shot out from the nucleus with inconceivable velocity and maintaining their rectilinear form while sweeping around the sun, in perihelion, notwithstanding their prodigious length and great angular velocity.

Comets frequently approach so near to the sun that we might well expect developments of electric energy incomparably surpassing anything presenting itself upon the earth; and if auroral currents can transport particles of our atmosphere to a distance of several hundred miles beyond its limits we may readily conceive that similar forces may carry portions of the extremely rare material composing the envelope of a comet to a distance of even millions of miles from the nucleus. The suspicion may therefore be indulged that *the tail of a comet simply indicates the position of a stream of electricity rendered visible by its illumination of particles of matter which it is constantly transporting from the nucleus with the velocity of electricity itself.*

rounded one of the terminals, whilst in others cloud-like masses of light were successively developed from one of the terminals, whence they passed towards the other terminal and were thus arranged in a line between them—their development being greatly promoted by the presence of a powerful magnet.

With a water-battery of 3500 cells, these are represented as faint and cloudy in their appearance; and with Grove's nitric-acid battery of 400 cells although the action was so intense that they became extremely bright they still retained their cloud-like form and motion. In describing experiments made with this battery, the exhausted receiver being placed between the poles of the large electro-magnet of the Royal Institution, Mr. G. says, "On now exciting the magnet with a battery of ten cells, effulgent strata were drawn out from the positive pole and passing along the upper or under surface of the receiver, according to the direction of the current. On making the circuit of the magnet and breaking it immediately, the luminous strata rushed from the positive, and then retreated, *cloud following cloud with a deliberate motion,* and appearing as if swallowed up by the positive electrode."

In another experiment with the nitric-acid battery Mr. G. says, "four or five cloud-like and remarkably clear strata came out from the positive." These were large lens-shaped masses arranged at regular intervals between the terminal wires, their flattened surfaces facing these terminals, as shown in fig. 2, pl. V, which is copied from Gassiot's figure (Proceedings of Royal Society, vol. x, No. 39, p. 401).

Now if in this case we imagine a small glass globe placed with its centre directly between the wires, it is evident that each of these cloud-like discs as it "came out from the positive" towards the negative terminal, must, while passing the glass globe be pierced by it, and be converted into a ring, (see fig. 3,) just as the auroral cloud was supposed to take the annular form in gliding over the spherical surface of the non-conducting atmosphere.

*This part of the auroral display may therefore prove to be some modification of the "stratified discharge"—the magnetic poles of the earth being the terminals, and the auroral arches being analogous to the cloud-like masses of light or glow described by Gassiot, the magnetism of the earth aiding in their development.**

* The following description of another of these experiments also seems suggestive of auroral phenomena:

"With the inductive coil the discharge in 146 exhibits a large cloud-like luminosity on the plate, which in those experiments was always made the negative terminal. On the positive wire minute luminous spots were visible. *At intervals apparently by some sudden energetic action, flashes of bright stratified light would dart through the vacuum,* but by carefully adjusting the contact breaker the discharge could be made to pass, producing a white glow on the negative plate, without, to the eye affording any appearance of an intermittent discharge."

In the "London, Edinburgh and Dublin Philosophical Magazine" for December, 1860, Prof. Rijke of Leyden mentions that M. Perrot had shown that the spark from a Ruhmkorff coil consists of a bright point of light combined with a "luminous atmosphere that admits of being displaced by a current of air or gas," which he had succeeded in separating from it; and that while the ordinary spark is entirely unaffected by magnetic force, "*this luminous atmosphere appears affected in precisely the same manner as the voltaic arc under similar circumstances.*" Now as the voltaic arc tends to revolve around the pole of a magnet, this "luminous atmosphere" or glow must do the same; and if the material composing the auroral arch be of the same nature we should expect it also to revolve from east to west, or the reverse, around the magnetic pole of the earth—the direction of its motion corresponding with that of the streamers. In the display of August 28th, 1859, such was actually observed to be the case, the fragments composing the arch, as well as the streamers, having a rapid motion from east to west.*

The foregoing considerations seem to render it probable that the aurora is essentially an electric discharge (see fig. 4, Pl. VI) between the magnetic poles of the earth,—leaving the immediate vicinity of the north magnetic pole in the form of clouds of electrified matter which float southward through the atmosphere at a height of forty miles or more from the earth, sometimes to a distance of more than thirty degrees from the pole; that whilst they are thus moving forward with a comparatively slow and steady motion, or sometimes even remaining almost stationary for a long time, bright streams of electricity are, from time to time suddenly shot out from them in a nearly vertical direction —that is to say in the magnetic curves corresponding to the points from which they originate: that these curves, ascending to a great height beyond the atmosphere, then bending more and more southward and downward until they finally reach corresponding points in the southern magnetic hemisphere, are the pathways by which the electric currents pass to their desti-

* The grand display of August 28th, 1827, seems to have been of a strikingly similar character. In "Hough's Meteorology of the State of New York from 1826 to 1852," p. 487, the observer at Lowville says, "The arc remained entire three-quarters of an hour, its highest point being at first about 10° north of the zenith, one of its extremities meeting the horizon a little south of east, and the other a little north of the west point. *During the existence of the arc its constituent matter passed in a rapid and ceaseless current from East to West;* and soon after the arc was formed it began to move (the extremities however advanced but little) in a southerly direction, and continued its progress until it descended as many as 40° south of the zenith, it then *was broken up into parallel pieces which moved majestically westward*, and gradually diminished in magnitude and lustre, till at length every vestige of the arc disappeared."

In most auroras the arch is situated so far north that it is too distant from observers in this latitude to permit them to determine anything as to the motion of its parts.

nation; and for several hundred miles from the earth these curves are thus "traced through space in the most distinct way and illuminated with bright electric light"—and further that the magnetism of the earth also causes these luminous currents and the electrified matter composing the arch to revolve around the magnetic pole of the earth, giving them the motion from east to west or from west to east, which the streamers and the components of the arch are observed to have.

DESCRIPTION OF PLATES.

Pl. V, Fig. 1.

N and S—The North and South magnetic poles of the earth.
n and *s*—The poles of an imaginary magnet representing the magnetism of the earth.
A, A′, B, and B′—Points on the surface of the earth.
ab, *cd*, *a′b′*, *c′d′* &c.—Auroral streamers.
ef and *e′f′*—Sections of auroral arches.
Z—The direction of the zenith to an observer at A.

The arrows show the position of the dipping needle at the several points A, A′, B and B′—and the dotted lines represent the magnetic curves passing through A and B.

An observer at A sees a corona having its centre at *a*—the streamer *ab* being seen endwise as a mere spot of light, and the streamers surrounding it appearing to diverge from it in all directions.

An observer at B sees a corona having its centre at *c*.

Fig. 2—Is copied from Gassiot's figure.
Fig. 3—Represents an imaginary modification of the same experiment.

Pl. VI, Fig. 4.

N and S—The North and South magnetic poles of the earth.

The East and West bands represent auroral arches, upon which stand the streamers. The dotted lines represent magnetic curves, and the arrow on one of the arches shows the direction in which the streamers, and the components of the arch revolved on the 28th of Aug., 1859.

Philadelphia, Jan. 31st, 1861.

Art. XXVIII.—*Remarks upon the Atoll of Ebon, in Micronesia;* by E. T. Doane.

We will begin our remarks upon the Atoll of Ebon by referring in a general way, first, to that section of Micronesia which embraces it, known as the *Marshall Islands*. The name is that given by *Krusenstern* in honor of Capt. Marshall who made the first discoveries there in company with Capt. Gilbert. The discoveries date back seventy-two years; the first island was seen in 1788, the last being discovered only in 1824.

The whole group lies within the longitudes 166° and 172° east, and 4° 39′ and 12° north latitude. Of the atolls of the group, some are large, measuring forty, fifty, and sixty miles in circumference, while others are mere bank-reefs, two or three miles in circumference. Of the large islands, we may mention *Jaluit* or Bonham's *Rimski Korsakoff*, or *Rong-rik* and *Rong-lab*,

and *Mille* or the Mulgrave Islands. Of the mere bank-reefs, we may mention *Kili* or *Hunter's* and *Lib* or *Princess* Island. And we would here remark, perhaps no group of the Pacific presents a more tangled mass in the nomenclature of its islands, than does the Marshall Islands, and especially the Ralik range. Some of the terms we have given above may perplex the reader as he attempts to trace them out on ordinary charts.

The Marshall Islands are divided by a deep sea about one hundred and fifty miles wide—into two chains—the Eastern or *Radak*, and the western or *Ralik*. Their general bearing is N.W and S.E. The Eastern chain possesses thirteen atolls and the western sixteen. The general features of these atolls are similar to those of most coral islands. They are low—the reef-rock in none probably measuring more than ten or twelve inches in elevation. In form, however, there is much diversity. *Mille* or Mulgrave island is nearly a parallelogram—*Majuro* or Arrowsmith is oval; *Ebon* circular—while *Jaluith* or Bonham's Island and *Arlinglab-lab* or *Elmore* Islands, and many others, are without any definite forms.

The atolls vary in fertility. Those south of 8° north latitude possess, from all native accounts, the most fertile islets and the most available soil. Their fertility may be accounted for from the fact, that more rain falls upon them. They are more affected by the equatorial belt of "constant precipitation" which is ever oscillating backwards and forwards over them. Dead leaves and wood rapidly decay.

It is an interesting fact, anomalous to the general features of coral islands, vide Dana's Coral Is. p. 24—that the *leeward side* of these islands possesses the largest body of land. Indeed the windward side of many of these islands is entirely destitute of land—or possesses it only in small islets. On *Mille* or *Mulgrave* Islands and *Majuro*, *Arrowsmith*, *Jaluith*, *Bonham's* Islands and *Ebon* islands which the writer has visited, this is emphatically true. The windward side of *Majuro* is possessed only of small islets, while the leeward side is one continuous strip of land, twenty-five miles long. *Jaluith* is much like this; perhaps, however, it has not so continuous a piece of land on the leeward side—though there is here the most fertile soil. On *Ebon* this is likewise true.

An explanation of this fact may perhaps be found, in the strong winds—the "N.E. trades" sweeping with all their force for one half the year over these reefs. These strong winds and the heavy sea they raise, tend to sweep off the material which might accumulate there; and bearing some portion on across the lagoon to the leeward side is there lodged, and helps forward most rapidly the accumulation of the "beach formation."

The fact has been stated, that the northern atolls of the Mar-

shall islands are rather subsiding than otherwise; vide Dana's Coral Is., p. 134. It may be asked, is this not rather apparent than real? May not the small amount of wooded land found there—for this is the basis of the statement—be owing rather to the heavy seas and winds which there prevail? The natives ever speak of the heavy winds of that latitude, 12° N. Islands have been desolated by them. We feel disposed to offer this as a solution of the fact.

Another fact, we would state as common to the whole group —is the existence of large ship channels on almost every side of the lagoon. *Mille* possesses four large ones—three of them, and one, the largest of all, on the windward side. *Jaluith* has its reef pierced by as many—and much in the same position. While *Majuro* has its channel on the windward side only, and *Ebon* on the leeward, we cannot speak of more from personal observation—though the natives say the other islands possess many channels and in much the same position of those above mentioned.

With these remarks upon the general features of the Marshall islands, we proceed to remark upon the atoll of Ebon.

The position of this atoll is 4° 39′ north latitude, 168° 49′ 30″ east longitude. This is the position, from the anchorage of the ship "Morning Star" in the Lagoon. The atoll is the most southern one of the *Ralik* range. It was discovered May 25th, 1824, by Capt. George Ray who named it Boston Island. In 1834 Capt. Covel thought it a new discovery, when it took his name, by which it is often called. The atoll is nearly circular and measures some twenty or twenty-five miles in circumference Except the passage on the west side of the reef, there is no other, not even a boat passage, in the whole circumference of the atoll. The reef however, at full tide, can be crossed by native craft. There is a tradition that once a passage existed, of sufficient capacity to admit ships, on the N.E. side, and that it was destroyed however by some powerful spirit, in his rage, and the present passage opened.

The natives possess also an interesting tradition concerning the existence of *a high island as having once occupied the most of the lagoon.* It is said the tall hills, covered with bread-fruit and cocoanut, reared themselves where now the flats in the lagoon exist. It is said also that what must then have been the barrier reef possessed land, which is now Ebon islet. The present passage is twelve or fourteen fathoms deep, and at the inflowing and outflowing of the tide has necessarily a very strong current, being the only outlet for the whole lagoon—when the waters are lower than the reef. As it flows in, against a strong wind, its presence may be traced quite across the lagoon, from the ripple of the waters and the white caps. The reef-flats near the passage in the lagoon are being covered with sand and other

coral debris—the nucleus of some future islet. The small coral patches in the lagoon are all covered with a few inches of water at low tide.

Ebon is the largest islet on the reef, as shown on the accompanying sketch—and gives name to the whole atoll. Its length from point to point is about eight miles. A singular feature is found upon it, a ledge of coral conglomerate. The map by the sign ↔ presents its position. On the north end of the islet it projects itself free from all soil or sand; and its course as marked, can easily be traced by its repeated outcropping. The land which lies on the sea side is of considerably more recent formation than that on the lagoon side. The difference is very perceptible. The ledge or embankment was formed, no doubt,

a, Ebon; *b*, Dile; *c*, Eniaithok; *d*, Kermkumlab; *e*, Eri Mon; *f*, Remrol; *g*, Koie; *h*, Minlak; *i*, Enear; *j*, Enikaiori; *k*, Riri; *l*, Teko; *m*, Bikri; *n*, Bivilil; *o*, Aneming; *p*, Enilu; *q*, Iu; *s*, Jurith; *t*, Eni-armith; *u*, Worai-thok-thok; *v*, The Komil; *w*, Morelab.

mainly from the wash of the lagoon. This is seen from its lamination sloping that way. It undoubtedly served an important purpose in catching and holding the finer materials thrown up from the lagoon.

At the S.W. bend of the islet the surface is quite uneven,—hills and vales in miniature form and size show themselves. They are formed no doubt by the drift of the sand—blown up into little hillocks. From its elbow round to the N.E. point the islet possesses but little soil. It is however covered with a quite heavy growth of bushes and trees, all possessing a very rich and deep green color—and this is indeed characteristic of the foliage of the whole island. It has none of that sickly yellow, half nourished hue, which we find upon many coral islands—those especially of the Kingsmill group. On Ebon all the growth is beautiful. There is soil and rain enough to nourish well the tropical vegetation.

I have not been able to obtain an exact classification of the plants of this atoll. More than fifty distinct species, however, will be found. We will mention some which enter chiefly into the support of native life. The Artocarpus is represented by some eight or ten varieties, one, the *A. integrifolia*—and the rest *A. incisa*. The *Pandanus odoratissimus* is represented by some twenty varieties. Its fruit enters largely into the native food. It is prepared in large rolls enclosed with its own leaf,—and may be kept for years. The cocoanut (*Cocos nucifera*) is represented by some ten varieties distinguished only by the nut. Two varieties of tarro (*Arum esculentum*) is quite plentifully grown. It is raised in large beds prepared somewhat for it. These beds differ from those found on the Kingsmill islands. They are not as there, excavations carefully worked out and good soil prepared and worked in. They seem in a measure to be natural excavations, perhaps the sunken hollows between hillocks. These hollows with some little preparation would answer the purpose:—at least their origin at this day is unknown. If a native be asked concerning them, he invariably refers them to the work of spirits. Around the margin of these arum patches, are grown bananas in quite plentiful crops. And the larger islets have just sufficient to raise oranges and figs, which the missionaries are now growing.

This atoll is the home for a few varieties of birds. But in this feature of the island, the contrast is as wide between the "low coral" island and the "high volcanic" one—as between their natural features. The high islands of Micronesia are largely supplied with the feathery tribe,—but this atoll can claim only a very few birds—and with two or three exceptions these are all water fowl. There are a few Columbidæ, *Carpophaga oceanica*, which manage to elude the keen search of the natives. These birds are occasionally heard cooing away in the tops of some quite isolated bread-fruit tree. A Cuculus gives forth occasionally its sharp whistle—and these, with the addition of another land bird whose species I have not been able to learn —are all the feathery songsters this atoll can claim.

The shores of the reef at low tide, and the bare rocks, are a little enlivened by the brown and white Heron. Small flocks of snipe (*Scolopax*) gather on the sand bars—or single individuals are running along the beach picking up food. An occasional plover (*Charadrius*) is to be seen. Sea swallows (*Sterna stolida* and *Sterna minuta*) are skimming the waters of the lagoon, or resting on the beach. A Booby (*Lula*) now and then is seen sailing over the island. His home is unknown to the natives. His want of caution is clearly seen in the easy way a native will ascend a tree in which the bird is roosting and with a slip-noose capture him. An interesting explanation of the origin of the single variety of the *Cuculus* is given by the natives—so skillful has this bird been in concealing its birth-place. As the natives find it only full grown they say that it is born and nourished in the clouds and falls to the earth of full size.

At least five species of reptiles are found on the atoll. Four are of the Lacertinidæ—and one, Geckotidæ. The Gecko readily domesticates himself, and lives upon the house flies and gnats he finds. The Lacertinidæ find their homes on trees and bushes.

The varieties of insects are interestingly numerous. It might seem as though these atolls, so comparatively recent in their origin would be but feebly represented by any varieties of animal life. But the entomologist will find here not an uninteresting field of study. The most common kind of insect is the parasite *Pediculus*, disgustingly numerous in the heads of natives; a large size Libellula, dragon fly, is quite numerous, and a few of the diurnal and nocturnal Lepidoptera are found. Of ants and mosquitoes and flies there are large swarms. Of the *culex* there is probably a new kind, which might be called *diurnal* culex. They are very small and almost as numerous as those more commonly seen at night. Of Scolopendra—Centipedes—there are many to be found and of rather formidable size—though we rarely hear of their biting any one.

There are several varieties of Spiders. The scorpion, though found on the atoll is small and harmless.

The Crustacea are numerous on land and in the water. We seem to have a great abundance of the Paguridæ—hermit crabs. I have thought they were more numerous on these coral islands than on the volcanic ones.

The Mollusca too are abundant. Some rare specimens are found. The orange cowry is common to some of the Lagoons. Zoophytes also are numerous, as would be supposed in these waters. A valuable and quite abundant sponge is also found in some of the lagoons and the Marshall islands.

It will be noticed, on the reef of this atoll, that besides the islet of *Ebon* there are nineteen others. All of them are much smaller than Ebon, though for their size they are equally fertile. Some of them seem to be veritable fairy-lands—so soft is the

green grass which covers them—and the deep shade of the interlaced bushes and majestically tall bread-fruit trees, throwing out their long sweeping arms like the monarch oak—

—"Who has ruled in the green wood long."

In the growth of some of these islets, we have perhaps some interesting facts connected with the rate of growth of islets or coral reefs. *Bikri* is an islet containing not more than an acre of land. A few Pandanus self-sown from seed washed there by the waters of the lagoon or sea, have taken root. And there are a few bushes,—a variety which I have noticed as growing only on the frontier soil of an islet—soil which is but little more than sand. From the leaves of these bushes and Pandanus, soil is very slowly forming. But *the present age* of the islet is, as stated by a native, who saw it when only a *sand bank* washed by the tides—some *thirty-five years*. He remembers it when a boy as only a sand bank. Now it has a *little* soil and *few bushes*. The islet *Nanming* he describes as once only a sand bank. It is now about the same size and condition as *Bikri*. These facts are not stated of course as definite for determining the rate of growth of coral *islets*—for into such a calculation many other circumstances might enter, such as the position of the reef for catching and holding the washed-up matter, &c. But we may learn from the facts here given, that the growth of land, like the growth of the reef-rock, *is very slow*.

Near the southern extremity of Toko (opposite *x* on the map) some *thirty-five* years since, there was a passage sufficiently large to let a proa pass over the reef between what was then *two islets*. Now that passage has been filled up, and large bushes grow there. The only tree of any size is the cocoanut and Pandanus, which have been planted. This fact we would state as illustrative of two points—one bearing on the fact we have just referred to—the rate of growth of an islet—and the other, that large islets are made by stringing as it were, together several small ones. It may be questioned whether a large islet, say some two or three miles long, is one continuous production; it was rather formed by several smaller islets becoming attached and the whole in time becoming one large islet. This fact I think can be clearly proved to have been the case with the growth of the islet of Ebon. There are several spots which may be indicated as the *welding* points of small islets. These places are usually narrower, and less overgrown with bushes and trees, and possess a thinner soil than other parts of the whole islet. Then again there are places which are *expanded*, just as if they had been the central nucleii of the islets. These are heavily wooded—have large bread-fruit trees and other trees of apparently an old age, growing upon them. We have reason to believe that all the islets of this atoll will in time be thus united, and thus the

whole reef possess, so far as it goes, one unbroken chaplet of vegetation.

We are now deeply interested in watching the formation of *sand banks* at one or two points. As yet they are shifting about —as the winds and seas prevail for a given time from any quarter; they are as yet covered by high tides. One of these sand banks is between *Eni-armeth* and the northern point of *Ebon*. We may not live to see it, but we believe that this sand bank will yet become *fixed*—will enlarge itself—catch some floating seeds and appropriate them and then there will be another green islet on the reef. This will again expand itself and become the connecting link of Ebon and Eni-armath—thus completing the length of the green band of this Ebon islet on its northern extremity.

Ebon Atoll, Marshall Island, Micronesia, Aug. 16th, 1860.

ART. XXIX.—*On Normal quasi-Vision of the Moving Blood-corpuscles, within the Retina of the Human Eye;* by LEVI REUBEN, M.D.

I. WHILE observing, in the summer of 1857, the apparent changes in the colors of natural bodies, due to transmission of the light from them through various colored media, I looked through a thick plate of deep blue cobalt glass at a clear, bright sky; and upon so doing, I at once noticed an appearance of movement of numerous minute, shining or lucid points, and seemingly in the space a foot or more forward of the eyes. These appearances, as then and often since observed, may be thus described:

1. The earliest impression was that some of the lucid objects showed as mere points, others as bead-like bodies. The bead-form is, however, in this experiment, an illusion, and due to a quick circuitous movement of some of the points.

2. The movements were by regular impulsions, or in jets; and as if, at each jet a new troop of these objects entered suddenly in all parts of the field of view—these moving, as the eye would pronounce, distances varying from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch, and then mainly but not all disappearing just before the next accession.

3. Owing to the quick movement, the effect was as if so many fine lucid lines were rapidly traced; and these were seen at the same moment, throughout the whole of the length already named; or, sometimes, the first formed extremity of the line was observed to vanish first. The lines were apparently not of light or color, but rather of *glistening*, or *lustre*.

4. The jets were *always* sensibly synchronous with the pulsations of the heart; the duration of the lines, from the half to the whole of a pulsation.

5. The movements were in all directions; in lines straight or contorted; generally indicating some divergency from certain points or from along certain lines; and only to be traced after some practice.

6. Thus aided, however, it soon became evident that, as long as the eye was not shifted, the moving objects kept in each part of the field to certain directions, upward along one narrow band, downward or obliquely along another, as if confined to particular channels or paths.

7. The blue glass showed the movements best; but the eyes were not at the time actually directed to the apparent place of the sky, but so that the optic axes met in the space seemingly occupied by the moving objects—not more than four feet from the eyes.

8. With this glass, there was no difficulty in converging the eyes to this space. The objects appeared so distinct, that the vision seemed involuntarily adjusted to them.

8. Yet it was easy to observe that if the eyes were forcibly directed to the sky, or if in any way the direction of the axes to the apparent field of the shining points was lost, the latter were less distinctly perceived; and with media of most colors other than the deep blue, were wholly lost.

The facts can only be reconciled with the hypothesis that the lucid lines are quasi-visible traces of the corpuscles of the blood moving in vessels in the retina; and that they were such, I became convinced during the first observation of them. That the blood can be only that of vessels *in* the retina, becomes certain when we remember—

a.—That these vessels lie in the anterior half-depth of the transparent retina itself.

b.—That the vessels of the choroid coat lie behind the retina or laterally to it, and imbedded in absorbent or black pigment.

c.—That in the eye, subsequent to birth, there are no vessels other than those in the retina, that lie in the course of the cone of rays admitted by the pupil.

Thus, these apparently trifling observations acquire at once both a physiological and a psychological interest, as showing the visual surface and the objects positively impressing it brought, certainly, to their extreme limit of contiguity! I have called this *quasi*-vision, because it does not arise from the presence of any object the rays from which are brought to foci by the crystalline lens; that is, the case is not one of ordinary vision. Yet there is a *positive impression* on the retina, and of just such kind that the mind interprets it into the vision of real, glistening objects in the air. The cause is a *subjective* one (physiologically considered); but the perception (so far as the mind is concerned), is clearly *objective* and *real*. That the phenomenon was not due to

any condition of my own eyes, I determined in my first experiment by desiring several others who were present to look toward the sky through the blue glass: every one (among them a little girl not quite seven years of age) readily discovered and correctly described the general characters of the movement.

With *lighter blues*, the moving points were less distinct and fewer; through a *deep green*, pretty distinct; but faintly and not easily visible through *light green*, or through *orange*. Subsequently I discovered them in tolerable distinctness on directing the unaided eyes toward the sky, or toward cloud-surface not too dark. In all these cases, diffused or daylight was the agent of vision. With all but the *deep blue* or *green*, or a *bluish-green* glass, considerable practice and some effort are requisite in order to *focus* the eye properly, an effect that seems to be secured at the same time with the converging of the optic axes on the proper field, for each hue employed. The greatest difficulty is experienced, as later experiments have shown, with *yellow*, *violet*, and *red* glasses; and with these, consequently, the vision of the lines is very fugitive and uncertain, while their number is small.

In Mackenzie's "Diseases of the Eye," the phenomenon, as witnessed by the unaided vision directed toward the sky, is mentioned as having been noticed at different times by different observers. I am not aware that before the observations I have now detailed, any one had noted the special applicability of colored media, or the superior vividness afforded by use of the cobalt-glass.

Regarding this glass as *dichromatic*—cutting off mainly both extremities and also the rays of the middle of the spectrum transmitted through it, and allowing the passage of two bands chiefly, the one blue, the other a hue of red, I was first led to believe, that, in connection with action of the blood-discs as lenses, dichromatism in the medium furnished an explanation of these phenomena. And, according to Wollaston's analysis of the light reflected from the atmosphere, this is comparable to that of a dichromatic medium, blue and red being also marked elements in it.

The substance of the results now stated, with an exception or two not touching the essential features of the phenomenon or explanation, I presented before the Photographical Society, of this city, June 13th, 1859, and more fully at the meeting following. Not then finding leisure to follow out my intention of offering an account of the subject for the pages of this Journal, I furnished a brief statement to Mr. Seely, and it appeared in the *Journal of Photography* published by him, July 15th, 1859. Professor Rood's observations, in this Journal, September, 1860, recalled the consideration of the subject, especially

as I was already able to add some other and quite as singular aspects of the phenomenon. Even before that date, I had also observed the appearance named in Prof. Rood's second note (Nov. 1860), of the field of view resolving itself "into a mass of small, round, densely packed moving bodies," or rather into several currents of such, moving in different ways; and though without publishing it, had mentioned the fact before the Society above named, giving, however, a different method by which the appearance could be secured.

Prof. Rood considers the lucid traces as *yellowish* in color; and explains them as due to complementary color subjectively arising, in a retina generally impressed with blue rays, along lines in which by passage of yellow blood-discs the blue light is momentarily intercepted. He admits, however, the fact of some appearance, even with the use of a *green*, *red*, *orange*, or *yellow* medium. He deems the indigo and violet rays as mainly influential in the result with the cobalt-glass. Let us recollect, however, that the *yellowness* of the stain of dilute blood is apparent only; the color of one or a few layers of blood-corpuscles must be a *tint* of the same hue possessed by the blood in mass, *i. e.*, of some hue of red. Then, on the hypothesis of complementary color, a *bluish green* glass (the complement of red) should show the phenomenon best; but it does not show it, so far as I have discovered, nearly so distinct as the cobalt-glass. Again, on the same hypothesis, the blood should be of the hue complementary to that of the cobalt-glass, namely, a *yellow* or *greenish-yellow*; but it is in fact red. Furthermore, a violet glass should show the appearance quite distinctly: it really does so only with the greatest difficulty, and then very few points. I have found that, with a yellow or orange glass, the points are few, but marked and bright; and with this medium they are still better seen by the reddish-yellow transmitted light directly following sunset, or at mid-day against whitish and highly illuminated cloud.

Thus I am led to doubt whether the explanation of the appearances can possibly be that they are due to complementary color. The yellowish hue of the lines is not always apparent (to me) with the cobalt-glass; but glistening or brightness always is. With glasses of other hues, it is very doubtful whether the lines show anything like the complementary colors. May not, then, the yellowish hue sometimes appreciable with the deep-blue glass be rather an incident, than in any way essential to the phenomenon? On the other hand, it is quite certain that the various colored media showing these moving points can not all be capable of a dichromatic effect on the transmitted light; so that, while this effect may, when present, operate in intensifying or otherwise modifying the phenemenon, I am led to consider the true cause of the latter as to be sought *in some effect of the*

*blood-corpuscles, acting as lenses, upon the minute pencils of converging and already almost focalized light entering the retina.**

II. In the communications already referred to, certain other facts and principles were stated, which I will briefly recapitulate, taking the liberty to present more clearly some points before implied:

1. Some of the lines did not remain lucid throughout; but before disappearing, along full half their length gave place to a distinct *black* line. This I have repeatedly observed; the change is marked and unmistakable. But owing to the brevity of the whole movement, I at first erred in judging that it was the last-formed half of the line that became black, and that the black portion was the narrower. I have since ascertained that it is the *first formed half* of the line that becomes black, and either very soon, or just before disappearance; and what is strange, this is uniformly the fact, except that in rare instances, to appearance at least, a line is traced that is black throughout and from the first. The supposed narrowness of the black line also seems to have been an illusion, but one readily accounted for on the principle of the tendency of any distinct luminous impression to extend itself upon the retina.

2. On looking with one eye through a pin-hole in white paper near to a bright gas-flame, and a little obliquely or to one edge of the opening, the bright lines appear; but now the motions are far more rapid and through longer sweeps, resembling very much, except in the brightness of the lines, the play of the eel-like animalcules of a drop of vinegar through the field of the solar microscope. With white paper and the yellow gas-flame, the lines are always of a light bluish-green. Along with and behind the lines, there is usually a mottled appearance, as of patches of bead-like bodies, either stationary, or in apparently slight commotion. Query: appearance of cells forming parts of the anterior layers of the retina?

3. At other times, owing to some slight and uncontrollable shifting of the adjustment of the eye, there appears, in like tint, a wholly different view: the field is now mainly occupied as with a pavement or floor of the small, stationary bead-like bodies; but in the middle of it, always in the very axis of vision at the time, there is a wholly vacant roundish space, apparently if not quite of the size of a three-cent piece. This I have very often witnessed; and the general characters of the appearance are constant.

4. This apparent opening or vacancy through the pavement-covered field of view, having its center always in the axis of vision, at once suggests that the phenomenon is another view of the cells or granules forming certain layers of the retina, but which for some reason are not to be detected over that slightly

* See a note on the Color of single blood globules, in this No., *Scientific Intelligence*—Physics.

elevated portion of the membrane corresponding with the *foramen centrale* and *limbus luteus*, or "yellow spot" of Soemmerring, and which is the seat of most distinct vision. It is difficult, however, to account for the non-appearance of the cells at this point since, anatomically, (beside the fact that the entrance of the artery and the insensible spot of the retina are close to or within its area, on the inner side), the only differences of structure from that of the other parts it presents, are greater tenuity as well as sparseness of nerve-filaments, and the want of the deepest or granular portion of the gray or sensific layer of the retina. Conjectures indeed, may point to the thinness of the retina here as the cause of disappearance of the anterior layer of cells; or, one may even assign this vacancy as the magnified area of the insensible spot.

5. Let it be remembered, further, that though the posterior layers of the retina are of *gray* or vesicular nerve matter, yet the layer is so thin that the color must be quite ineffective; so that the retina through its whole depth is nearly as transparent as water. A consequence is, that this membrane consisting of an expansion of the optic nerve and of ganglionic nerve-substance back of it, is not, as commonly taught, a *screen*, receiving a picture having superficial dimension only; it is, on the contrary, a minute *depth* of impressible though transparent tissue; so that retinal images generally must have *depth*, as well as *area*, and we may say, a real, though in one direction quite limited, solidity of form.

6. Now the red blood-discs, the most numerous variety, moving in the vessels lying directly in front of, and partly in, the impressible portion of the retina, and, which, in the small capillaries are probably separated in most instances so as to advance singly or in very small groups, become comparable to so many minute *lenses*, shot at every pulsation in various directions athwart and in the transparent mass of the membrane. If the capillaries are large enough to admit discs without compression, they remain slightly bi-concave, and supposing them to differ in density from the blood and the retina, their effect must be, if they lie with the concave sides transverse to the rays of light, to overcome part of the convergency given by the crystalline lens, or to cause the minute pencils transmitted by them to diverge. If, however, they present themselves edgewise to the light, *i.e.*, if their concavities are transverse to the paths in which they are advancing, then we may suppose, either, that in the direction vertical to their path they act as convex lenses; or that, while this is the case, certain rays entering at their edges in such part as to strike afterward, from within, either of the surfaces that are outwardly concave, and of course inwardly convex, would undergo total reflection, and so an additional effect of concentrating or massing together the rays would occur, the whole being

brought to a focus more quickly or brighter in itself; and thus, the disc would project this bright pencil just beyond it into the impressible layer, and necessarily carry it along with its own motion. But if the capillary, as is sometimes the case, be too small, so that the red corpuscle becomes wedged, then it has been observed, under other circumstances, to be variously changed in form, usually inclining to globular; and the latter is the form also of the few white corpuscles contained in the blood; so that in these instances the effect of a minute spherical lens is secured or approximated.

7. But, are the corpuscles more dense than the serum and the nervous mass, so that they can act as lenses? It is well known, first, that the specific gravity of healthy blood slightly exceeds that of *brain;* and I shall have to assume that the density of the retinal substance is not essentially different, as its composition and structure are not, from that of brain. But again, in blood whose coagulation is delayed for a few minutes after withdrawal from the veins, the red corpuscles are found rapidly sinking through the liquid, so that the clot thereafter forming is at top yellowish only, or of buff color, and the serum is quite red. The white corpuscles are to a greater extent entangled in the clot. Hence, it must be inferred that at least the red corpuscles have a density distinctly greater than that of the blood, and in all probability, than that of the retinal mass; and this is all that is necessary to show that they *must* act as lenses upon any light which they can transmit.

8. And this brings me to the question, can the *red* blood discs transmit light of any hues, even green or blue? It must be recollected that, in the minute capillary vessels, these discs can no longer advance in masses of several in thickness, but must advance singly, or at most in layers of two or three deep. In such a case, the blood-discs can hardly present a hue deep enough to render them effectively colored, that is, *opaque* to their complementary color. The thickness of two red corpuscles advancing side by side with their longer diameters presented in the direction of entering rays, would not exceed in all about the $\frac{1}{1400}$th of an inch. Now, let us suppose a solution of the same absolute intensity of red as that of the blood, introduced into a wedge-shaped glass of very gradual taper, and in which the film could, near the edge, be brought to a thinness of $\frac{1}{1400}$th of an inch: how much of the spectrum would the red medium at this degree of tenuity cut off? how much of the intensity of a green or blue beam would it destroy? Inappreciably little, it appears to me; and this view is sustained by an experiment named in Prof. Rood's paper. He says: "Yellow solutions, when combined with the blue glass or blue solutions, render the circulation invisible; and it does not re-appear till the yellow solution has been made *so dilute as barely to preserve a yellow tint, and to transmit the spectrum*

almost unaltered." The words which I have here italicized describe exactly what is true in regard to the *red tint* of dilute blood, and of course of the single attenuated streams of blood in the capillaries. The experiment itself disproves the possibility of a real or effective opacity of the blood-discs for green or blue rays. In seeing a blush on the cheek of another person, the eye takes in at once the hue of tens of thousands of closely aggregated capillaries; and here the intensifying effect of concentration is experienced. But in witnessing the movement of the blood in the retina itself, the field is as it were spread out, and near objects thrust apart; and the effect of each pencil so small as to pass through one corpuscle, or two or three in succession, is noted by itself; so that no intensifying of color by mere contiguity can here occur.

9. The explanation I was at first inclined to give of the quasi-visibility of the moving blood-discs, by use of the cobalt-glass or against blue sky or cloud simply, was that of regarding it as an instance of *glistening*, adopting Dové's theory, (as modified by Brewster,) that the perception of glistening or lustre is consequent in some way upon the mental effort to reconcile or combine images formed at slightly differing depths in the retina. The lights employed in the cases now named, or at least in the first two, have prominent a blue and a red pencil. These are of refrangibilities considerably differing. Now, the eye not being perfectly achromatic, the several prismatic colors are focalized at the same time at slightly differing distances from the lens, *i. e.*, at slightly differing depths in the retina. In case of white light, or colors nearly allied, there is so close a sequence of these images, and they overlap, or rather, inter-permeate each other, so nearly, that their hues blend into a single resultant image, white or of the dominant hue, with which the mind occupies itself, the colored borders, or rather *surfaces*, of the image being relatively so slight as to escape perception. But when a dichromatic beam passes to the retina, certain intermediate hues having been mainly eliminated by the medium, there are two images or sets of images that do not so nearly coalesce; an image by the more refrangible rays placed anteriorly, and one by the less refrangible, posteriorly, within the retina. But, bi-concavity of the corpuscles would diverge, say, the blue rays more than the red, producing increased brightness along certain moving points back of the corpuscles, where the two kinds of rays would then come nearer to one focus; or bi-convexity would affect the blue rays again the more distinctly, in the way of increasing the convergency before given by the crystalline lens; and thus the two images might be still more separated, and the effect of glistening, or no sensible effect, should then be anticipated. But, since it is not supposable that yellow, red, and certain other glasses transmit more than one sheaf of closely-allied hues, the supposition of dichromatism fails to be

applicable to these; and being set aside as but an incidental, possibly a modifying circumstance, no probable hypothesis other than that of action of the corpuscles as lenses seems to remain.

10. Another curious phenomenon I early observed, and one for which I have not been able even to imagine a cause. It appears with most of the media used, especially with the darker colors; and usually precedes or attends the vision of the shining traces. It consists in the vision of many very minute but very real black motes or points, that do not sweep off, but are in rapid and considerable agitation, or *swarming*, as it might be termed, over the whole field of view. These appear to be more distant than the lucid points, and equally diffused; and they are seen very constantly.

11. In Professor Rood's second paper, he speaks of the "densely-packed moving bodies" already referred to, as being seen when the light of a salted wick is condensed on the eye, and better when a yellow glass is interposed; and he adds that Professor W. B. Rogers obtains the like appearance by fixing the eye on a bright surface, until that organ is fatigued, or looking through a tube of black paper at a white surface. In my later experiments, made the last summer and autumn, I was surprised at finding this effect produced on closing one eye and laying over the other, open, a paper, white or of any hue not too opaque, and standing with this eye near to a bright gas-flame. The quiet steady flow of minute objects is soon discovered more or less perfectly forming itself in the field of view; it grows more clear, and is seen to consist of many streams in different directions, each keeping its own course; and the appearance suggests streams covered with fine floating ice. But the eye must be rightly focused, looking apparently into the space quite near to it; the appearance easily vanishes, and is hard to recover. It may be observed when a leaf of an ordinary book is laid over the eye, under the circumstances named, or when yellow, greenish, red, or other paper not too dark is used. The color of the objects approaches more or less nearly that of the complement of the medium. The steady flow of the bodies seems to show that they cannot be the same as those seen with the blue glass; and appears to intimate that, while the latter are in the arterial extremities or in the first extremities of the capillaries, so that they still feel the impulsion of the heart, the "floating-ice" objects are in the radicles of the veins, where their propulsion is uniform and their numbers greater.

III. The following notes I select from among such as I have taken down during some of my latest experiments, the past autumn:

a.—With a bright sun; view of the sky about 20° from the sun, through the cobalt glass: When the lucid lines are best seen, and

the eyes adjusted to their place, there is always at the same time a pretty distinct consciousness of the back-ground (sky or cloud) as distant, and as being, directly before the eye, *mottled* with prismatic colors, faint but real; sometimes taking the appearance of mosaic pavement, or of small colored *cirro-cumuli;* so that when the glass is aside, one is disappointed at seeing no cloud, or one of different appearance. In this case, the colors seem mainly *blue* and *red*. The effect I had somewhat unconsciously noticed before; have seen it very positively many times since. Sometimes the appearance is that of fine colored powders mixed; sometimes it is, though faint, quite beautiful, as if the groundwork were of confused rainbows. It is seen more or less distinctly with glasses of nearly all colors. But it vanishes the moment the eyes are directed to the sky, and may reappear when they are again focused to the near field of the moving discs.

b.—Same time, and medium: the lines are mostly lustrous only; very few give even a faint impression of yellow. The spot in the axis of view has least in number; and the eye catches more as it is turning a little to one side. Best seen when the eyes converge to the objects.

c.—Against same sky, through single amber yellow glass: the moving points seen as minute, not colored, few, very bright, quick-moving, and fugitive. Through two thicknesses of the same glass: points fewer, and more fugitive, but quite well defined.

d.—Through dark green formed by combination of yellow and light blue: Looking long and steadily, the eye finds the field of the objects, and so adjusts itself as to see many of them, though only tolerably distinct.

e.—Through grass-green glass: The shining lines readily and distinctly seen; a few quite defined. They show *no tinge of red.*

f.—On another occasion, with the cobalt-glass, against the sky: all the phenomena beautifully made out; the more distant swarming, black points plentiful; the traces of the blood discs numerous and distinct; and a considerable proportion of them turning to black lines just before disappearing,—the black line always at the end first or longest formed, and extending down to a defined extremity, where it *abruptly* changed to, and was continued by, the lucid portion. I could not, however, make out that the black line began at the first-formed extremity, and ran down the course of the whole line; though this may have been so. The black and the bright portions both suddenly and completely disappeared.

g.—Same time, and medium: Found, very evident and certain, a larger channel or spot of ingress where a more numerous, crowded and confused body of the moving objects came at every pulsation, pouring in, *as if from without or beyond the rest, toward*

the eyes; and plainly thus discovered, not as moving in, *but as emerging into the field of view.* This spot seemed, with two eyes, a little to left of the axes of vision; and from it several streams arose. Query: the termination of the *arteria centralis*, or of one of its large branches?

h.—Looking with but one eye, this point of ingress seems very near the axis of vision; and sometimes there is the appearance to be named in the next paragraph.

i.—Looking to the west, clear sky, soon after sunset; through red glass; some few moving points; but chiefly, in the axis of view, a continual influx of a small stream of very small bead-like objects, faint, but real; seeming to move only into the field, and to disappear almost at once through it; not spreading out in it. This appearance I had noticed first of all with a violet glass; and with violet, red, or blue, it was often repeated. By shifting the eye, the movement could be made to occur apparently upward, or to one side; but it seemed to return usually to the downward course. I distinguished this as the *cascade.* The uniform movement seemed to forbid the supposition that this could be the appearance of the corpuscles in the artery; and hence, its explanation is doubtful.

k.—Upon momentarily closing and opening the eyes, there was an appearance of a *rosette-shaped space*, its centre always in the axis of vision, which distinctly and always showed the complementary color of the glass before the eye at the time. This appeared with all glasses; it showed where the axis of vision pierced the sky at the time; and that the cascade was in this axis, the point of jetting in of corpuscles (*g*) in or very near it. This rosette seemed to me to mark the limits of distinct vision on the retina, the portion most impressed by the color of the medium employed. Having observed it, as now named, I could from that time be less distinctly conscious of it, while looking at the moving objects, or other appearances. Thus, through the cobalt-glass, a yellow central spot was really at all times faintly obvious; through green, a reddish spot of like size, and so on.

l.—With glasses showing the moving points faintly, I often succeeded in bringing them out more distinctly for a little while, by having just previously used those of complementary color.

m.—Looking at midday against light cloud: The cascade, small, but very perfect, flowing up, or down, appeared through the cobalt-glass; more faint, through orange, red, and violet. To see any moving traces of the corpuscles, with yellow or red glasses, it was found necessary to compress the eye-ball, as could be done by making the effort to retract it, and to look into a space very near the eyes.

In regard to the facts mentioned in (*k*), it should be added, the traces of the discs were visible both in and around the cen-

tral area of the field, or that which showed the faint complementary color. And the arising of this color after a few moments' use of any of the colored media, seemed to show that, over the most sensitive portion of the retina, the tendency to the perception of the secondary subjective color, or that which follows the impression of a previous and different one, is even stronger than the present impression of any given color, so that the subjective complementary can here displace even the actual or acting color!

IV. The singular results which these observations seems to furnish, then, are the following:

aa.—*Quasi*-vision of moving blood-discs; showing, incidentally, also the places and courses of certain capillaries of the retina.

bb.—Discovery of *some change*, in which the momentarily illuminated trace of the disc, in some cases, and usually at a little distance behind the advancing disc, gives way to *black*.

cc.—*Quasi*-vision, in different ways, of the cells or granules in anterior portion of the retina.

dd.—Discovery, by apparent absence of these, of either the entire seat of most distinct, ordinary vision ("yellow spot"); or else, of the place of the insensible spot, magnified. The latter view doubtful.

ee.—Appearance as of numerous, swarming, black points.

ff.—*Quasi-vision* of numerous small bodies, moving close together, and apparently steadily, in unlike directions, but so that the several streams cover nearly the whole field; as if the contents of many capillaries, or venous radicles, close together.

gg.—Obscure perception of finely mottled colors, at the same time with vision of the moving discs.

hh.—*Quasi*-vision of place of influx of a considerable proportion of the discs into the field of view; suggesting the artery, or a large branch of it.

ii.—*Quasi*-vision of single stream, seen only in a brief course through the field, and seemingly without impulsive movement —the *cascade*.

kk.—Perception of nearly circular, or rosette-shaped area, of subjective color, corresponding with the seat of most distinct vision.

ll.—The actual visibility of this subjective (complementary) color, within and in spite of the generally diffused presence of the opposite color at the time.

V. Among principles incidentally discovered or affirmed in course of the discussion, appear to be the following:

aaa.—That the traces of the moving blood-discs are not invariably, nor necessarily, of a color the complementary of that occupying the surrounding retina at the time.

bbb.—That the blood-corpuscles, single or sparse, as in the retinal capillaries, can transmit, without appreciable diminution of intensity, rays of any color. In this way the coloration of the fine parts of images of pictures, landscapes, etc., on the retina, is not, during our view of the objects, continually interfered with.

ccc.—That moving blood-discs, within the capillaries of the retina, according to their form and position, may affect the light passing through them in various ways, by lens-action or total reflection.

ddd.—That images in the retina are variable in their place, (within the limits constituting, on either hand, myopia or presbyopia), by minute changes of *depth;* and are composed of a series of solid images of as many colors as the light admitted to the eye contains, and more or less perfectly coalescing.

Moreover, as general facts bearing on the explanation of the phenomena now detailed, the following propositions seem to be established:

eee.—That the eye or eyes, in order to discover any of the appearances named, must be *focused* or adjusted for vision of an object at some certain distance. This necessity of focusing the eye explains why, usually, the appearances are so readily lost.

fff.—That this adjustment differs for light of different colors, the implied distance of the object being greater or less. Observations seem to indicate that the distance of the imaginary object is least for the red rays, and less generally for the less refrangible.

ggg.—Hence, when either appearance is seen by merely looking steadily toward a lighted surface, or until the eye is fatigued, it is probable that, involuntarily, the proper focusing or adjustment of the eye takes place.

hhh.—With the single exception, if it be such, of the case of looking steadily at a bright surface, or with the eye fatigued, the light with which any of these phenomena is discovered, is never white or complete light, but always partial, of special colors and refrangibilities.

That is, all the media, or lights, showing these effects, are such as afford rays of not all, but some certain refrangibilities. All these general facts agree with the supposition that the blood-discs become *quasi*-visible by means of their effect as lenses. Although we may not be able to say in what way, *precisely*, each part of the phenomena results, it appears certain that the discs, and in certain other cases the retinal cells, so modify the convergency of rays entering the retina through them, or perhaps in some intances, the divergency of more refrangible rays which have already passed their focus and spread out, (at the very time that red and yellow rays have their focal distance and proper effect),

that the impression of the retina through many of these bodies must be decidedly different from that which it receives or yields around their place. We may say, generally, that the visible corpuscles or cells become so from the fact that in certain ways and degrees they *complement* the effect already impressed on the light by the crystalline lens and the humors of the eye. This view suggests a ready explanation of the circumstance that media of different colors require a convergency of the optic axes toward points at different degrees distant from the eyes; since we must presume that this is one instance of "associated movements," and one in which, accordingly, the mere telescopic adjustment of the place and convexity of the crystalline lens, will be made to correspond, involuntarily and accurately, as in ordinary vision, with the degree of convergency voluntarily or otherwise given to the optic axes.

The change by which certain of the lucid lines are replaced through a part of their length by black, it is difficult to explain. The effect can hardly be that of the accidental or subjective production of black (total absence of impression), succeeding a previous impression of brightness; for, were it such, it should be more general, and follow through the whole length of the bright line. Assuming each line to be not less than twenty times longer than broad, and nearly as broad as the corpuscle could appear, if seen bodily in its place, then the black portion is seen to follow at some distance behind the advancing corpuscle. Is it due to the collapsing wall of the capillary, or to changes in its liquid contents, such as to result, a little way behind the corpuscle, in certain cases, in a brief *total interference* of transmitted rays?—or, such as to produce along an inconsiderable length of the vessel the effect of *total reflection*, excluding momentarily the light from that part of the retina directly behind its place?

Finally, it needs hardly be said that, in order to observe many of the phenomena now considered, much care and patience will be required, and not less an eye so delicately sensible to color that it can appreciate the finest colored points and very faint tints. And the caution must be added, that experiments of this kind can scarcely be protracted very long at any one time, or repeated continually for weeks or months, with no long intervals of rest, without the risk of permanent injury to the delicate organization of the eye.

New York, Jan. 16th, 1861.

Note:—*March* 15.—Since the above was written, Sir D. Brewster's paper enumerating "Certain Affections of the Retina" (*Philos. Magazine*, Jan. 1861), has appeared, but containing no allusion to vision of the blood-discs. To the list, this, and certain related phenomena quite as singular, it appears, may now be added.

ART. XXX.—*Upon some Experiments connected with Dove's Theory of Lustre;* by Prof. O. N. ROOD, of Troy.

IN the *Farbenlehre*, p. 177, Prof. Dove writes: "In every case where a surface appears lustrous, there is always a transparent or translucent reflecting stratum of minor intensity, through which we see another body. It is therefore externally reflected light in combination with internally reflected, or dispersed light, whose combined action produces the idea of lustre."

Thus by combining in the stereoscope two projections of a pyramid, one drawn in black lines on a white ground, the other in white lines on black ground, Dove found that the pyramid appeared lustrous as though made of graphite. [To me it recalls rather the idea of highly polished glass.] He found also that a yellow and blue surface when combined in the stereoscope and viewed through a plate of violet glass, produced, in the act of combination, the idea of a polished metal.

Similar to Dove's theory of lustre is that of Prof. Ruete.*

This view of the nature of lustre opens to us the possibility of reproducing by the stereoscopic combination of suitably colored surfaces, the individual lustre and appearance of gold, copper, brass, &c.; it also affords us a means of examining separately the components, which *may produce* the appearances peculiar to each.

1. I combined in the stereoscope on white or on black grounds —a piece of tin-foil one inch square with a piece of yellow paper of the same size. The value of the tint on the chromatic circles of Chevreul was, 1st circle, orange-yellow, No. 4. When the field containing the tin-foil was somewhat shaded by the hand or otherwise, the surface seen in the stereoscope could not be distinguished from gold-leaf. The union of the images took place as readily and the illusion was as strong with persons unaccustomed to the use of the instrument.

2. By combining in the same way tin-foil with orange-tinted paper, (1st circle, orange,) the lustre and appearance of copper is imitated.

3. Tin-foil in the act of combination with Nos. 14 and 15 of the red and black scale imitate bismuth.

4. Tin-foil or silver-foil in the act of combination with ultramarine paper appears scarcely blue, rather black like foliated graphite.

5. Gold-leaf in combination with paper of a tint nearly that of the green of the 1st circle imitated murexide.

6. Gold-leaf in combination with ultramarine paper resembled a surface of graphite.

* *Das Stereoscop;* C. G. Th. Ruete, Leipzig, 1860.

Upon substituting dark grey paper for the tin-foil the same effects in degree were not produced, owing as it seemed to me, to the fact that the well known texture and appearance of the paper forcing itself on the attention, precluded the idea of anything metallic. To remove this difficulty I employed two means.

1. A crumpled sheet of tin-foil was photographed, and from the negative, prints were taken, by the "ammonia-nitrate process," which were toned to the so-called black of the photographers. This furnished dark paper upon whose surface was an accurate drawing of the irregularities characteristic of metallic foil; the surface of the paper was of course wholly without lustre.

(*a*) Upon combining, in black or white fields, a square inch of one of those photographs, with the above-mentioned yellow paper, and shading the photograph a little, a representation of gold was obtained but little inferior to that given by the use of the real tin-foil.

(*b*) This photographic paper in combination with orange paper (1st circle, orange), made an imitation of metallic copper.

(*c*) The ultramarine paper in combination with the photograph of tin-foil gave a striking imitation of foliated graphite. The blue color is perceived much less than would be expected.

2. The surface of a plate of brass 1 inch square was polished, and then rather heavily scratched by a coarse file. Into the scratches a small amount of yellow or white oil paint was rubbed, and upon this prepared surface dark grey or black paper was laid and the whole submitted to the action of a press as in copper-plate printing. By this means a drawing of a scratched metallic surface was transferred to paper. These markings serve also to enable the observer much more easily to direct his attention simultaneously to the two impressions presented.

(*a*) Upon combining dark grey paper (black and white scale, Nos. 18, 19, 20,) prepared in this way with the above-mentioned yellow paper, the appearance of a polished, scratched plate of gold was obtained.

(*b*) When these dark prepared papers were combined with yellow paper colored by gamboge (yellow and black scale, No. 9), the appearance and lustre of brass was obtained.

According to Dove's theory the darker surface in the stereoscope represents the dispersed light, the brighter, that regularly reflected. As the polish of a metallic surface is proportional to the smallness in amount of the light it disperses, we should be led to expect that by varying the shade of the black paper, we should be able to alter the apparent degree of polish of these imitated metallic surfaces.

This is the case: yellow paper, (1st circle, orange-yellow No. 4,) in combination with black (No. 21,) gives the idea of a very

highly polished golden surface; as we descend in the scale, the lustre and resemblance to polished metal regularly diminishes till at grey, No. 8, almost no effect like gold is to be perceived.

On the other hand by diminishing the brightness of the yellow paper, the black tint remaining constant, the idea of a polished golden plate in the shade, or so placed as to reflect the image of some dark object, is produced. Thus we may descend through the circles of Chevreul to the 7th, when by combining the orange-yellow of that circle with No. 21 of the grey scale, the idea of a golden plate much shaded is produced. I constructed tables expressing the effects produced by varying the intensity of the two components, but it is not worth while to introduce them here.

As we are accustomed to see gold tinted variously from nearly a yellow as in gold-leaf, to almost a copper-hue as in some specimens of our American coin, so the tint of the paper placed in the stereoscope, may be varied within certain limits, without greatly affecting the results.

Prof. Helmholtz in his admirable work on physiological optics,* mentions that by a peculiar arrangement he was able to cause the homogenious golden yellow light of the spectrum to appear brown, proving thus that the tint brown is only weak yellow light. These stereoscopic experiments give us on the other hand the means of apparently converting brown into a metallic golden yellow, for many specimens of even brown wrapping paper, when combined in the stereoscope with very black prepared paper, acquire the lustre and appearance of yellow plates in the shade, and reflecting images of dark objects.

In the same manner, and corresponding to the investigations of Helmholtz, I found that the stereoscopic union of black glazed paper with red, (No. 14, red and black scale,) imitated with surprising perfection the appearance of a glazed plate of chocolate.

The chromatic scales of Chevreul furnish us with a ready means of combining in rapid succession in the stereoscope a great number of definite tints; thus by cutting in a card-board two parallel apertures $\frac{3}{16}$ inch broad and one inch long, their distance apart being 2·6 inches, and pasting under one of them black prepared paper, the other can be brought over any desired tint and the effect noted.

1. In this way I found that a pretty good representation of the appearance of slightly tarnished lead was produced by the stereoscopic union of grey No. 18 and No. 4 on the blue-violet and black scale.

2. A somewhat inferior imitation of antimony was given by No. 1 blue and black scale, with gray Nos. 18 to 20, or by using No. 17 blue and black scale with white.

* P. 281. *Physiologische Optik* (*Encyklopädie der Physik*, Leipzig, 1860.)

3. Tarnished zinc surfaces may be imitated by the use of grey No. 5 with No. 18 blue and black scale.

4. Ultramarine paper with some of the lighter violet blues gave an imitation of blue glass. The idea of blue polished glass was also obtained by using in combination with the ultramarine paper No. 1 of the yellow and black scale.

I will mention here that the stereoscopic union of this blue with yellow paper, never induced in my mind the idea of green.

I made some experiments to ascertain how far the *stereoscopic* mixture of two masses of different colored light corresponded to their true mixture by the method of rapid rotation, use being made of the imitations above described. It is however so difficult to compare a varying with a fixed tint that I will not record the results obtained; in many cases a certain moderate amount of agreement in the resultant tints was observed. Brücke found that when a deeply colored yellow glass was held before one eye, a blue cobalt glass before the other, that a landscape viewed through this combination was simply darkened in appearance. I repeated this experiment with similar glasses and obtained a like result; objects appeared darkened, but in their natural colors, though sometimes the blue or yellow tint predominated a little. But when I presented to a *single* eye these two masses of light a very different result was obtained; the plates of glass were attached to a blackened disc opposite suitable perforations, and it was set in rapid rotation; a landscape viewed through it appeared deep purple, though not a trace of this color was to be perceived in the binocular use of these glasses.

When these two glasses were held before the same eye, a landscape viewed through them was very much darkened but scarcely colored.

Sir David Brewster's Theory of Lustre.

Sir David Brewster opposes Dove's theory of lustre, as he has found that when black and white surfaces without drawings are combined in the stereoscope, no lustre is produced. The lustre, then, according to this philosopher is due not to one mass of light passing through another, but to the effort of the eyes to combine the stereoscopic pictures.

Admitting the correctness of Sir David's experiment, Dove has shown that the objection founded on it is without weight—(p. 3, Optical Studies).

In repeating Brewster's experiment I always obtain the *opposite result*; in combining uniform black and white surfaces, without drawings, I always obtain a distinct impression of lustre, like that of the blackened mirror of a polariscope, and in strict accordance with Dove's theory, when the black field is so darkened that *no light* is sent from it to the eye, this lustre vanishes,

and the white paper alone is perceived. This disagreement is not a cause of astonishment when we reflect that de Haldat's original experiment waited nearly half a century for confirmation.

To Brewster's own theory, the simple objection, which has already been made by others, that we daily perceive lustre plainly with one eye, would seem sufficient.

Production of Lustre in Monocular Vision.

I proceed now to describe some experiments where by the action upon a single eye of two masses of light of unequal intensity, the idea of lustre is produced.

1. If a disc of colored card-board, out of which a number of sectors has been removed, be made to rotate rapidly, and an object be viewed through it by a single eye, two masses of light will reach the eye, which apparently proceed from the object; one is reflected from the surface of the disc, the other emanates from the object behind the disc, and passes through the first mass of light. Dark objects viewed in this way assume to me to a small extent an appearance like that of blackened glass. The effect is not at all striking, and would be overlooked by many persons; I therefore prepared paper in a peculiar way so as to imitate distantly the appearance of foliated graphite or crumpled mica.

White smooth drawing paper was rubbed over irregularly with a brush *slightly* moistened with a weak wash of India ink or lampblack; when dry another wash of a deeper hue applied as before, care being taken to leave many small spots untouched. The final wash was laid on with pure black. If the brush be kept nearly dry and passed only lightly over the paper, it is easy to obtain a surface bearing some very distant resemblance to the minerals above mentioned; it is of course without lustre. Similar papers were prepared with red and blue water colors.

When these papers were held behind discs of ultramarine or orange-tinted paper, from which equal alternate sectors had been removed, and which were revolving at such rates that their surfaces seemed uniform, or at lower rates, they often appeared, to a single eye, highly lustrous. This was true of the prepared paper in a *state of rest;* when moved slightly by the hand it glittered strongly. Dark photographs of tin foil held behind a revolving disc of ultramarine paper and viewed by a single eye, assume often to a striking degree the lustre and appearance of foliated graphite.

2. If a piece of this peculiarly blackened paper $\frac{1}{2}$ of an inch square be placed in a blue field, (rather light ultramarine paper,) and be steadily regarded for some minutes by one eye it assumes a red orange-hue and appears suspended over the blue paper

and nearer to the eye than the latter; at the same instant it appears lustrous like crumpled mica. The illusion with me often lasts half a minute in great perfection; this is particularly the case when the eye is not quite accurately focused on the paper.

3. If a sheet of this prepared paper be brightly illuminated by light from a window, and be held so near one eye as to produce indistinct vision, it often apparently becomes highly lustrous. In this case enlarged images of the white and grey points are formed on the retina which overlap, so that again we have two masses of light, one passing through the other.

4. If a *roll* of black paper like the above, but coarser in its markings, be brightly illuminated on one side and viewed through deeply colored plates of glass (red, green, blue,) in a few seconds it appears lustrous resembling a roll of polished zinc which has been irregularly and deeply corroded by an acid. Upon removing the glass the surface of the paper appears lustrous for an instant.

5. A sheet of the finer variety of this prepared paper viewed through a large rhomb of calc spar gives often in spots the appearance of lustre, particularly when the head of the observer, or the rhomb, is slightly moved. Some persons compared this to the appearance of water.

It would seem probable that in all cases where two masses of light reach a single eye, one passing through the other, particularly when there is any *perception of their individuality*, that the appearance of more or less lustre is produced, though from habit we often overlook it. Thus Helmholtz remarks* upon the combination of two colored surfaces in monocular vision by means of a simple instrument he figures:—"It is particularly favorable when the drawings, or spots on the two surfaces are made to shift their position. Then we often believe that we see both colors simultaneously in the same place, the one through the other. We have an impression in such cases of seeing objects through a colored vail or reflected from a colored surface."

I found in fact that by placing stereographs consisting of colored paper for one eye and a photographic drawing of tin-foil for the other in this instrument, that lustre could be perceived, particularly with the imitations of copper.

The diagram represents the instrument referred to; it consists of a plate of glass, P, with parallel sides, which is properly supported over a blackened board B. Differently colored papers are placed at K and Y; one is seen through the plate, and the other by reflexion from it. The images are made to overlap and their intensity is regulated by altering their distance from F.

* *Physiologische Optik*, p. 273.

Analogous to this is the observation of Brewster.* Speaking of uniting similar pictures, (patterns on hanging paper,) in binocular vision, he remarks:—"The surface of it, (the wall) seems slightly curved. It has a *silvery transparent aspect.*" Here the images though of the same intensity, &c., moving with each slight movement of the head induces in the mind the idea of one object seen through another.

In closing I will remark that while many of the experiments above mentioned are easily repeated, others require considerable practice in this kind of observation.

ART. XXXI.—*The Quaternian or Diluvian Period, considered in its relation to the present Epoch;* by F. J. PICTET.

[From the Bibliothèque Universelle (Archives) de Genève, vol, viii, p. 255.]

WHEN in 1844, the first volume (1st edition,) of my elementary treatise on palæontology was printed, I was struck with the impossibility of fixing a precise limit between the Diluvian epoch and the present or modern period. These two periods, it is true, have been considered as distinct in all treatises upon geology; but when I attempted to point out their palæontologic characters, I soon perceived that the zoologic population had not in reality been modified in passing from one to the other, and that they are evidently the uninterrupted continuation of one and the same state of things. This truth appeared to me so evident that I merely indicated the principal arguments which supported it,† without entering into details, and I considered it sufficient, to call the attention of geologists and palæontologists to this point. This has had its influence, and recently, since questions of this nature have taken a new importance by the discoveries relating to human fossils, many geologists have admitted the above conclusions as demonstrated. I would especially mention Mr. Scipio Gras,‡ who is engaged in an important work on the diluvium of the valleys of the Rhone and the Rhine, and also Mr. Lartet,§ who has recently sustained the same opinion in a memoir upon the geological antiquity of the human race in western Europe.

There are however some opponents to these views, especially Mr. Kœchlin Schlumberger,‖ who replying to Mr. Scipio Gras, has called my opinion *a little radical* and has sought to overthrow

* The Stereoscope, p. 91, London, 1856.

† *Traité élémentaire de paléontologie*, note B, 1st edition, tome i, p. 359.

‡ *Bulletin de la Société géologique de France*, 2d Series, tome xv, p. 167.

§ *Bibl. Univ.* (*Archives*), tome viii, p. 193. July, 1860.

‖ *Bulletin de la Société géologique de France*, 2d Series, tome xvi, p. 88. Nov. 21, 18.9.

it. I therefore think it necessary at this time to furnish new proofs and to set forth more clearly those evidences which have decided my own mind, and which I have no doubt will convince the most incredulous.

This question may be considered from two points of view, the geological and the palæontological. I shall only approach the question in the latter aspect, for which my studies have better fitted me, but I ought to remark that we have no example of serious disagreement between palæontology and geology when they are employed to distinguish the several periods of the history of the globe. There is no one of these periods which is not clearly distinguished by the character of its fauna, and no case can be cited where stratigraphy has required a division which palæontology has not confirmed. If we survey the whole series we never find any two consecutive stages in which the zoological population has been identical.

If this is so, the geologists and the palæontologists will be unanimous for uniting these two epochs into one, and for applying to them a common name. I think if I am able to prove, from the standpoint of palæontology, that the two periods are only one, this result ought to be as fully admitted as in analagous cases for anterior epochs.

I know that this opinion is not without question, and that some geologists, whose learning and judgment I highly respect, think that in the condition of the globe and the forces which have existed since the termination of the tertiary period there are sufficient reasons for distinguishing completely the tertiary period from the modern epoch. I shall not discuss this question for which I do not think myself qualified. I will only say that however this may be, it will be impossible for me to assimilate the separation of two periods whose fauna are continued identical from one to the other, to the well determined limits which distinguish geologically and palæontologically all the anterior periods admitted as divisions of the history of the globe. I have elsewhere intimated that these same geologists are singularly embarrassed in regard to the precise point where they ought to establish the division, and that the long series of Quaternary deposits, following the glacial period, which certainly neither commenced nor ends suddenly, will give them very great difficulties.

My object in this communication is simply to demonstrate that between the Diluvian period and the modern epoch there has not been any modification of the fauna having the least relation to the changes which characterize and distinguish other palæontological faunæ. For this purpose I shall consider two distinct points. I shall demonstrate first that *all* actual or modern faunæ have existed from the origin of the Diluvian period. I shall

inquire afterwards what differences exist between the Diluvian fauna and the present fauna and shall show that they consist only in the disappearance of a limited number of the larger species.

I ought however before proceeding to details to notice an objection. Of late years questions relating to the origin of species have been reviewed with renewed ardor, and some persons think that the solution of these questions may have an influence upon the demonstration of the question with which I am now engaged. On the contrary I think the subject with which I am concerned is entirely an independent question. Whether we admit with Lamark or with Mr. Darwin a gradual transformation of beings, or think there is a general law of nature introducing, at certain epochs, new organic forms, or accept the idea of successive creations, we shall in either case be obliged to refer to the same facts in the history of the globe. At the end of a certain number of years or centuries the zoological population of a country is changed and the species are replaced by others. The surface of the globe has been successively occupied by a series of faunæ perfectly distinct; each of these fauna corresponds to a period which it characterizes. Whatever theory may be entertained in regard to the cause of the change, the change itself is not questioned. But all we need to do here, is to show that these organic differences characterize the successive periods, and that there is no such difference between the Diluvian period and the present epoch.

I ought, as I have said, to demonstrate in the first place that all the present faunæ have existed from the commencement of the diluvian period, as well as the last species, of which I shall speak farther on. For this purpose I have recently arranged a complete catalogue of the fauna of European mammifers, and I have inquired which have not been found in the fossil state, and what are those the bones of which have been found buried in the Quaternian or Diluvian beds, with the fossil elephant, *Elephas primigenius* or with the Cavern Bear, *Ursus spelæus*.

Reasoning upon comparable and sufficiently certain facts, I have excluded from this list:

1st, Marine mammifers in view of the difficulty of determining the age of marine Quaternian deposits.

2d, Mammifers of remote regions whose bones are not likely to be found in the more explored and better known diluvian deposits of Central Europe. Thus I have not considered as important either the monkey of Gibraltar, or the small species on the confines of Asiatic Russia, or those which have been recently discovered in Sicily or in Turkey. I have confined myself to those actually living in places where the Quaternian deposits are well known. Besides this, the excellent work of Eichwald

proves the existence of the same state of things in Russia as in England, Belgium, France, Germany or Switzerland.

The following are the principal facts obtained from an analysis of my catalogue, viz:

Almost all the common species of *Cheiroptera* have been found in the Quaternary deposits. I have found, especially those here cited: *Vespertilio*:—*V. noctula*, *V. pipistrellus*, *V. serotinus*, the *common bat*, the lop eared bat, *Vesp. auritus*, the *fer à cheval*, the *V. discolor*, and the *V. mystacinus*. Is it not extremely probable, not to say evident, that the rare species more recently discovered which are wanting upon this list, are wanting because we have not known how to distinguish their bones or because they have not *yet* been found? What geologist will venture to affirm that, the varieties *V. Leisleri*, *V. Kuhlii*, &c., which only appeared before the species named above, appertain to a more recent fauna.

The same results are furnished by the *Insectivora*.

In these same Quaternary deposits are cited the hedge-hog, the mole and three or four species of the shrew-mouse.

This is all our fauna, for, on account of the reasons mentioned above, I am not able to give any importance to the two species of *Mygale* ('*desmans*'), one from the Pyrenees and the other from Russia, which have not yet been found in the fossil state.

The group *Rodentia* is of difficult determination and we may naturally expect to find some vacancies, but there are none, however, of any importance. We may cite the squirrel, the marmot, the dormouse, the mouse, the hamster (*Crisetus*), the water-rat, the ordinary meadow-mouse, the beaver, the hare, and the rabbit. The only striking vacancy will be that of the porcupine, but Mr. Arcas has fortunately found this also in the caverns of Sicily. There are wanting to our list only some small species of the mouse, the garden dormouse, the muscardin, &c., in regard to which we may make the same reflection, as was suggested by the Cheiroptera. The jerboa, lagomys, &c., are found as fossils in Russia.

The *Carnivora* being in general larger than those animals which represent the preceding groups and being at the same time more easily recognized scarcely present any vacuity.

There have been found the lion, cat, wolf, domestic dog, fox, genet, white bear, brown bear, badger, glutton, martin, beech martin, polecat, ermine, weasel and the otter. There is lacking to this list only the lynx, and it is important to know whether the *Felis engiholensis* of Schmerling, from the caverns of Belgium is not identical with it. I have not supposed that any person could see an indication of a subsequent creation in the absence of some species from excentric regions as the fox of the north, the polecat of Poland, or the *P. boccamela* of the Mediterranean islands.

The only *Pachyderms* of the present fauna yet found in our Quaternary deposits are three, the wild boar, the horse and the ass.

Among *Ruminants* have been enumerated all our present deer, the deer properly so-called, the reindeer, the moose deer, and the roe-buck. The fallow deer is not comprised in this last, but, as is well known, it is not native in Central Europe. There are enumerated also the wild oxen, (the urus and the bison), the chamois, and the goat. The sheep had not been discovered until the last few years, which had probably been more recently imported; however, Mr. Arcas has found in the caverns of Sicily a closely related species, the *mufflon*. Finally, to this series of animals, modern discoveries authorize us to add *man*. All this, as I have said elsewhere,* appears to demonstrate that man has coëxisted with this diluvian fauna and that his history dates probably from the same epoch.

The facts here mentioned are remarkably conclusive, for they prove that all the present fauna of European mammifers have been found as fossils in the Quaternary deposits, except some small species difficult to be determined, the bones of which if preserved, have not yet been recovered. It appears to me evident that these rare exceptions are without value as objections, and that we may boldly declare that: *From the commencement of the Diluvian period to the present day, no species of mammifers has been added to the fauna which then lived in Europe.*

What we have said of mammifers may also be affirmed of birds and reptiles; but upon this part of the subject I shall not enter into details, for these classes are less known and do not furnish results so certain. The examination of a treatise on palæontology is sufficient to show that the existing species are already indicated in the Diluvian deposits.

The terrestrial and fluviatile mollusks are in the same category. Thus with the bones of the *Elephas primigenius* are frequently found buried all our species of Helix, Bulimus, &c., and they show us that for the invertebrata as well as for the vertebrata, all the existing fauna date from the origin of the Diluvian period.

The preceding facts suffice to show that there has been no renewal of the fauna between the Diluvian period and the Modern epoch. We must now consider in what consists the apparent difference which has led most geologists into error. It has been caused by the gradual disappearance of a certain number of species. At the commencement of the Diluvian period the fauna was richer and more complete than it is at present. There lived in Europe at that time not only our present animals but a certain number of species which are now extinct. These latter have gradually disappeared from causes probably in part similar to

* *Bibl. Univ.* (new series), tome vii, p. 364. March, 1860.

those which destroyed one species of ox mentioned by Julius Cæsar, and which destroyed most likely the last representatives of the ure-ox (aurochs) and the elk. The fauna of the eastern continent has been successively impoverished, and as the population and cultivation of the soil increased only a part of the species which once dwelt there remain living.

It is not possible, in the present state of palæontology to prepare a complete and precise catalogue of these extinct species; but it is sufficient for our purpose to sketch the principal features of such a catalogue.

I am embarrassed in regard to the Alluvial deposits of Auvergne, which appear to present characters somewhat exceptional. It is not perfectly demonstrated that the fauna which they enclose has all been contemporaneous with the Quaternary deposits of the greater part of Europe. There are found many species as yet imperfectly known which appear to be extinct and which have not been recovered elsewhere. Such is the *Erinaceus major*, many of the dogs, some polecats, at least three species of deer, the wild goats of Roset, &c. It will probably be necessary to add to them hereafter; but new investigations appear indispensable to make the proper additions with certainty. I have experienced some doubt in regard to many races or species of true Quaternary deposits, indicated as different from those now living, but which have been characterized without doubt by their form and not by appreciable organic characters. It appears to me quite natural that species at the commencement of the Diluvian epoch, finding abundant nourishment in a country where great forests and immense virgin territories replaced our present culture, and being able there to develop in freedom should have frequently had a form a little superior to their existing representatives, which, surrounded by hunters, restrained on every side, lead a more difficult and precarious life. I do not think it possible to give a specific value to slight differences of stature, if all the other characters are identical, and therefore I consider as doubtful many of those species inserted in the catalogues of palæontology. Such are the *Talpa fossilis*, the *Meles Morreni*, the *Lutra antiqua*, the *Sciurus priscus*, the *Arctomys primigenia*, the *Myoxus fossilis*, the *Sus priscus*, &c. Some of these are probably identical with living species. By new researches we shall find that some of these are truly extinct.

But aside from these difficulties and doubts a certain number of species have certainly disappeared which I will briefly enumerate.

In the family of *bears* I consider as lost the great Cavern Bear (*Ursus spelæus*). Their bones characterize well the deposits called Diluvian, or the formations more ancient than the last period of our globe. The *Ursus priscus* is more doubtful

and is probably identical with our black bear. The *Hyenas* appear to have been represented in the ancient epochs by three species which have now disappeared; the hyena of caverns (*H. spelæa*), analogous to the spotted hyena of the Cape of Good Hope, the *Hyena Monspessulana*, of Christol, more similar to the striped hyena, and the *Hyena intermedia*, Marcel de Serres.

In the family of the *felinidæ*, we should add to the wild-cat, the lynx (?) and lion which have disappeared from Europe in the historic period, another species related to the leopard, (*Felis antiqua*).

The numerous order of *Rodents* appear to contain some extinct species more different from the living than those which I have cited above in speaking of differences of form. These are the *Spermophilus superciliosus* of Kaup; the Castor (*Trogontherium*) *Cuviere*, Fischer de Waldheim; the *Lepus priscus* Cuvier, from the breccias of the Mediterranean, and some species of *Lagomys*, &c.

The *Elephant* is one of the most remarkable of the genera among those which have made a part of the ancient fauna of our period. Their bones are, with those of the bear, the most characteristic of these Diluvian strata, since they are abundantly scattered over an immense surface of country. The species best known is the mammoth (*Elephas primigenius*). Of other bones may be mentioned those of the African elephant (*E. Africanus*). The existence of some other species (such as the *E. meridionalis* Nesti), is contested by some anatomists and admitted by others.

The great *Rhinoceros* with valved nostrils (*R. tichorhinus*) less widely diffused than the elephant, and probably also one or two species of the same genus, are striking examples of those races which have disappeared.

It is the same with the *Hippopotami* of which it is thought we may admit the prior existence of many species now extinct (*H. major*, *H. minor*, *H. Pentlandi*, and the hippopotamus of the valley of the river Sômme).

The horse of Pézenas appears to be another species different from the one mentioned above as related to the existing horse.

The genus *Cervus* has been numerous from the commencement of the diluvian epoch, for to the species now living, and which, as I have said, existed then, is to be added the beautiful giant stag of the peat bogs of Ireland (*Cervus euryceros*), the great deer of the Sômme (*Cervus dama giganteus*) the *Cervus martialis*, Gravais, and many species from caverns described by Marcel de Serres.

Among the other species of *ruminants* lost from our fauna, it is necessary to mention the *Antelope Christoli*, M. de Serres, the *Dichotoma*, Gervais, and *Ibex Cebennarum*, Gervais.

I will not add the *Bos primigenius* because it was seen alive by Julius Cæsar.

I have not found among birds or reptiles any species to add with certainty to this list.

We shall find only a few in this category among the terrestrial invertebrata. The marine deposits on the borders of the Mediterranean contain some mollusks of lost species, but their numbers are small compared with species still living.

We thus see, as I have said, that the fauna originating at the period which succeeded the Tertiary epoch has been successively deprived of many remarkable species. This gradual disappearance may have proceeded from many natural causes. First the climate, cooling very much as the formation of great glaciers proves (Glacial period), would not be favorable to any one of them, especially to the great pachyderms, the congeners of which characterize in our day the torrid zone. Still more as I have said elsewhere,* admitting the presence of man from the origin of the latter period, we may, with much probability attribute to him the destruction of a part of the species. If we examine the list which I have given we shall see that, aside from the great pachyderms, it is principally composed of carnivorous animals which man is interested to destroy, and of herbivora which should serve for his nourishment.

Mr. Lartet, in the memoir which I have cited, has furnished a new argument in favor of this hypothesis. He has found marks of the instruments of man upon the bones of many species of this epoch, and in particular upon those of the ox and the goat; these marks being generally deep cuts designed to cause the rupture of the bone, sometimes more superficial wounds as if the object had been to elevate the skin about the base of the horns. This destruction of species is merely like that which daily transpires before our eyes. If new circumstances should cause the laws in regard to the chase to be abolished, and if the great land-owners did not protect some species, it would not be long before all our present deer would be classed among extinct species. They have already disappeared from many countries, and among others from the valley of the Rhone, where the stag and the roe-buck were abundant at the end of the last century.

A curious fact has been cited which seems to confirm what I have said, it is the very limited number of species of small size, or little connected with the wants of man, among those which have disappeared.

Such is the opinion which has been formed in regard to the causes of this extinction. I repeat therefore that these causes can

* *Bibl. Univ.* (new series), tome vii, p. 371, March, 1860.

have no relation to those which acted during the previous periods, for in the renovation of the fauna there has always been a replacing of some species by others.

Here, on the contrary, we merely find extinctions which can no more furnish a basis for distinguishing two periods than could the destruction of the *Bos primigenius* or that of the Dodo.

To complete our knowledge of the history of the Diluvio-modern period, it would be very interesting to ascertain the date of the extinction of each species. Some investigations of this kind have been recently undertaken, principally in England; but observers generally content themselves with stating the relation of bones to the Quaternary epoch without other details. It is important always where it is possible to determine accurately the position and the geological relations of the stratum which encloses them, and sometimes even to indicate whether they are found in the upper or the lower part of the stratum. It is important to examine with great care the bones in the deposits of the glacial epoch, for it is very probable that many species have extended even to that period. By such studies well directed we may obtain more accurate knowledge of this series of extinctions, and I doubt not we shall be more and more convinced that they have been gradual and successive.

Art. XXXII.—*On the Presence of Phosphoric Acid in Igneous Rocks;* by James Schiel.

Descending from the Sierra Nevada into the plains of the Sacramento river by the route which leads along Black Bute, we meet west of the Bute with a phosphoritic trachyte crumbling into pieces and covering the surface for many miles. As there is hardly a trace of organic substance to be discovered in the soil from which a luxuriant vegetation is springing, it was to be expected that the rock contained phosphoric acid.* This an analysis showed to be the case. The phosphoric acid is contained in the precipitate obtained by ammonia after a pulverized portion of the rock has been disintegrated by fluohydric acid, heated and dissolved in chlorhydric acid. The washed precipitate is dissolved in a small quantity of hot chlorhydric acid, much tartaric acid and some sulphate of magnesia added, and then the phosphoric acid precipitated with an excess of ammonia; the crystals of the phosphate are forming immediately. The amount of phosphoric acid contained in the rock was thus found to be 0·26 per cent corresponding to 0·78 per cent of phosphate of lime.

* Fownes (*Prize Essay*, 1845) demonstrated the general presence of phosphoric acid in crystalline rocks.—Eds.

ART. XXXIII.—*Ninth Supplement to Dana's Mineralogy;* by GEO. J. BRUSH, Professor of Metallurgy in Yale College.

List of Works, etc.

C. F. RAMMELSBERG: Handbuch der Mineralchemie. 8vo, pp. 1039. Leipzig, 1860.—This work is by no means merely a new edition of Rammelsberg's former "Handwörterbuch des chemischen Theils der Mineralogie." It is entirely rewritten and rearranged, and, as its title indicates, it aims to give the complete history of the chemical properties of each mineral species. It has seventy pages of introductory matter upon the analyses of minerals—the calculation of analyses—a discussion on the value of analyses—the chemical constitution of minerals, including the function of water—heteromorphism, isomorphism, homœomorphism, etc. The whole is arranged according to a convenient chemical classification.

Rammelsberg has done more to give precision to our knowledge of the chemistry of minerals than any other chemist since the time of Berzelius. The present work is one of great value to the mineralogist, the grandest work of the kind ever published—still on careful examination, we are sorry to observe evidences of haste, if not carelessness, in its preparation. It is to be regretted in such a standard book—as this is sure to become—that the author had not given it a little more time and care. This is particularly to be noticed in regard to American minerals:—on page 6 we are told that the native copper of Lake Superior contains 7·29 pr. ct. of silver and 0·03 of mercury; admitting that the specimen examined by Hautefeuille may have contained both silver and mercury, it is unnecessary to offer evidence to the contrary in regard to the thousands of tons which are yearly produced from this region, as shown by the careful investigations of Whitney, Jackson and others.

In many cases where an analyst has made several analyses of one mineral, the author gives the mean result only; this might be well enough, were it not that he very often omits to mention the fact, and compares the results of an extended and careful research, with a single and frequently imperfect analysis, a procedure which certainly has a tendency to create error, and mislead the student who places implicit reliance in this work. Thus, under Danburite, p. 770, examined by Shepard, Erni, and Smith & Brush, we find one analysis by Shepard, one by Erni, and one by Smith & Brush. The natural inference is, that but one analysis was made by each of the two first named, and one by Smith & Brush—had such been the case perhaps Rammelsberg might have been justified in his remark, "that with such differences in results, the nature (composition) of the

mineral remained in doubt." But how does the case stand—and we may be allowed here to remark that there is no doubt as to the identity of the mineral examined by Shepard, Erni, and Smith & Brush; Prof. Shepard recognizes the mineral examined by us as Danburite, and the writer furnished Dr. Erni the specimens on which his analysis was made.—Shepard's analysis gives 5·12 of alkalies and no boric acid, Erni found 14·13 p. c. of alkalies and 10·04 boric acid. Smith and Brush published two complete analyses, and besides showed by direct experiment that the mineral contains no alkalies (this Journal, [2], xvi, 365). No allusion is made to this latter fact in the work before us, but from the simple composition of the mineral, the experiments must be admitted as conclusive in proving the absence of alkalies, and no further discussion of the first two analyses is needed. Other instances of this kind of omission are found under Carrolite, p. 111, Anal. 2 being the mean of three—Cuban, p. 118, Smith's results are overlooked—Hydromagnesite, p. 233, Anal. 2, is the mean of two, four analyses were published—Jenkinsite, the analysis given is the mean of two—Pinite, p. 835, Anal. 7, is the mean of three—Euphyllite, p. 845, the earlier analysis by Crooke is given, while those of Erni and Garret are omitted; Smith and Brush made four analyses of two different varieties finding some 8 pr. ct. of alkalies which had been overlooked by Garrett, Erni and Crooke, one variety analyzed was from the identical specimen examined by Erni and Crooke—Enceladite, p. 888, an early analysis by Hunt is given; Rammelsberg does not seem to be aware that Warwickite and Enceladite are not only identical, but they are the same mineral from the same locality, both containing boric acid.

Rammelsberg proposes to apply the name GIBBSITE to the phosphate of indefinite composition examined by Hermann, notwithstanding this name was first applied by Torrey to a pure *hydrate of alumina*, and the results of the latter have been confirmed by four other chemists. The author gives as his reason, that Silliman. and Smith & Brush found a small amount (0·57–0·67 pr. ct.) of phosphoric acid, consequently showing the presence of a mixture of phosphate and hydrate of alumina. We add, that if this be admitted, the reasoning applies with much more force to the Russian *Hydrargillite* in which Hermann found 1·43 per cent phosphoric acid! The mineral described by Dr. Torrey is a native hydrate of alumina, and Gibbsite having many years precedence, there is no reason for arbitrarily replacing it by the name Hydrargillite. It matters not what Hermann analyzed, it is an indisputable fact that Torrey's Gibbsite is hydrate of alumina, and furthermore such a change of names as our author proposes, is against all usage, and followed out would cause endless confusion in nomenclature. We have

noticed only points in regard to American species; other examples might be quoted to justify our assertion that the work, although of great value, is marred with evidences of haste in its compilation, but we would not overlook the great services its illustrious author has rendered to the science of Mineralogy, of which no better evidence could be quoted than the work we have before us.

Dr. ERNST WEISS: Ueber die krystallographische Entwickelung des Quarzsystems. 4to, pp. 102. Halle, 1860.

ALBRECHT SCHRAUF: Ueber die Krystallformen des Kieselzinkerzes. 8vo, pp. 27, mit 6 Tafeln. Wien, 1860.

ALBRECHT SCHRAUF: Krystallographisch-optische Untersuchungen über die Identität des Wolnyn mit Schwerspath. 8vo, pp. 15, mit 3 Tafeln. Wien, 1860.

H. DAUBER: Ermittelung krystallographischer Constanten und des Grades ihrer Zuverlässigkeit (21. Akanthit). 8vo, pp. 18, mit 5 Tafeln.

C. F. RAMMELSBERG: Ueber Isomorphie und Heteromorphie bei den Singulosilikaten von Monoxyden und Sesquioxyden. Pogg. Ann., cix, 584–94.

J. REINHARD BLUM: Handbuch der Lithologie oder Gesteinlehre. 8vo, pp. 356, mit 50 Figuren. Erlangen, 1860.

W. H. MILLER: Crystallographic Notices, containing observations on the Employment of the Stereographic Projection of the Sphere in Crystallography; on the Measure of the Dihedral Angles of Crystals; on the Cleavages of Rutile; on the doubly-refractive character of Thermophyllite. (*L. E. and D. Phil. Mag.*, [4], xix, 325).

J. P. COOKE: Crystalline Form not necessarily an indication of definite chemical composition; or on the possible Variation of the Constitution of mineral Species independent of the Phenomena of Isomorphism. (*L. E. and D. Phil. Mag.*, [4], xxi, 406, and *this Journal*, xxx, 194.)

E. SÖCHTING: Die Einschlüsse von Mineralien in krystallisirten Mineralien, nebst Betrachtungen über die Entstehung von Mineralien und Gebirgsarten. 8vo, pp. 357. Freiberg, 1860.

DES CLOIZEAUX ET DAMOUR: Examen des propriétés optiques et pyrogénétiques des mineraux connus sous les noms de Gadolinites, Allanites, Orthites, Euxenite, Tyrite, Yttrotantalite et Fergusonite. Ann. de Chim. et de Phys., [3], lix, 357.

A. DELESSE: Recherches sur les Pseudomorphoses, pp. 76. (Extrait des Annales des Mines, xvi, 1860.)

AQUILLA SMITH: A new Pyrognostic Arrangement of the Simple Minerals hitherto found in Ireland. (*Dublin Quar. Jour. Sci.*, No. 1, Jan. 1861.

E. J. CHAPMAN: A popular exposition of the Minerals and Geology of Canada. Under this title, Prof. Chapman has contributed a series of interesting articles to the Canadian Journal of Industry, Science and Art.

A. KENNGOTT: Uebersicht der Resultate Mineralogischer Forschungen in Jahre 1859. 8vo, pp. 212. Leipzig, 1860.—A complete review of the Mineralogical Researches published in 1859, with additional observations and critical notes by Prof. Kenngott.

H. KOPP UND H. WILL: Jahresbericht über die Fortschritte der Chemie, und verwandter Theile anderer Wissenschaften, für 1859. Giessen, 1860. 8vo, pp. 903.—Pages 765 to 820 contain Prof. Kopp's excellent review of the progress of Mineralogy for 1859.

R. HERMANN: Heteromeres Mineral-Systems. (Zweite umgearbeitete Auflage). 4to, pp. 214. Leipzig, 1860.

V. v. ZEPHAROVICH: Ueber die Krystallformen des Epidot. 8vo, pp. 22, mit 2 Tafeln. Wien, 1860.

Descriptions of Species.

ACMITE.—For a memoir on the crystalline form of this mineral by vom Rath, see *Pogg. Ann.*, cxi, 254.

ALBITE [p. 240, VI, VIII].—An interesting variety of albite occurs associated with smoky quartz at Moriah in Essex County, New York. It has a greenish color and a peculiar lustre resembling green diallage. Cleavage very perfect, showing with great distinctness the triclinic striations. G.=2·633 (Brush). Analysis by Mr. Edward H. Twining, Assistant in the Laboratory of the Yale Scientific School:

Si	Al	Fe	Ca	Mg	Na	K	Ign.
67·01	19·42	0·95	0·39	*tr.*	11·47	0·25	0·24=99·73

AKANTHITE [II].—Kenngott considers the mineral from Copiapo described by W. J. Taylor as *stromeyerite* (Suppl. VIII) to be a cupreous variety of *akanthite;* excluding the iron found in the analysis as FeS_2 the remaining sulphids of silver and copper are in the proportions of 4AgS to 1CuS (Kenngott, *Uebersicht*, 1859, 115). For a memoir on the crystalline form of *akanthite* see Dauber in Ber. Wien. Akad., xxxix, 685. Dauber describes a new locality of this mineral at the Himmelfurst Mine near Freiberg. Sp. gr. of Freiberg specimens 7·192—7·199, from Joachimsthal 7·246. At Freiberg it is associated with argentite and stephanite. Analyses of *akanthite* by P. Weselsky show it to be identical in chemical composition with argentite. Specimens from Freiberg contained 86·71 silver, 12·70 sulphur; from Joachimsthal, 87·4 silver. AgS requires by theory 87·03 Ag, and 12·97 S.—*Ber. Wien Akad.*, in *Jour. prakt. Chem.*, lxxx, 487.)

ALUMINITE [p. 389, II].—Analyses of *aluminite* by Geist (1) and Dieck (2) from the vicinity of Halle show, according to Heintz, that the specimens may be mixtures of different basic sulphates of alumina, (Kopp, *Jahresbericht*, 1859, 811):

	S	Al	Si	Fe	Ca	Mg	H	
1.	22·18	39·86	1·92	0·40	0·50	0·03	34·91[a]	=100·00
2.	15·56	36·54	——	——	——	——	46·89	= 98·99

(*a*) by the difference.

AMMIOLITE [p. 142, II].—F. Field has published (*Quar. Jour. Chem. Soc.*, xii, 27) an extended examination of a *red mercurial mineral* occurring with mercurial tetrahedrite, atacamite, malachite, azurite, limonite, and silicate of manganese and copper at Tambillos near Coquimbo in Chile. It differs materially from the *ammiolite* de-

scribed by Domeykó, especially in regard to the action exerted upon it by acids; still Field considers that it is only a variety of the mineral, derived from the oxydation of a mercurial tetrahedrite. Purified by prolonged digestion in nitric acid, the red powder was found to contain in two different specimens:

	Hg	Sb	S	Fe	Ĥ	Si	
1.	34·42	14·21	5·43	2·68	4·46	35·50	= 96·70
2.	37·94	15·26	5·98	2·94	4·98	29·78	= 96·80

Dividing the sulphur equally between the mercury and antimony, making the former a simple and the latter a tersulphid, and oxydizing the remainder of each metal, then considering the silica and oxyd of iron as accidental impurities, and deducting the water, we have, according to Field's figures:

	HgO	HgS	SbO_3	SbS_3	
I.	31·77	35·53	15·61	16·52	= 99·43
II.	33·36	34·83	14·92	16·77	= 99·88
Mean,	32·56	35·18	15·27	16·64	= 99·65

Field considers that this composition may be represented as a tribasic sulphantimonite of mercury combined with tribasic antimonite of the same metal ($3HgS, SbS_3$) +($3HgO, SbO_3$) equivalent to HgO 32·93, HgS 35·37, SbO_3 17·07, SbS_3 14·63= 100. Or, he suggests further, it may be regarded as an oxysulphid of mercury coupled with an oxysulphid of antimony with the formula $3(2HgO, HgS)+(2SbS_3, SbO_3)$, giving the same percentage and composition. [We do not clearly see the relation between these two formulas, in the first we have three atoms each of HgS and HgO, and one atom each of SbO_3 and SbS_3, and in the second formula 6HgO, 3HgS, $2SbS_3$, and one atom SbO_3. It is evidently impossible for these formulas to give the same percentage composition.—G. J. B.]

Apatite [p. 396, I—VIII].—H. Reinsch has found in the phosphorite of Amberg not only chlorine, fluorine, and iodine, but also bromine.—(Kopp, *Jahresbericht*, 1859, 805.)

Bamlite.—See under *Sillimanite.*

Batrachite.—See *Monticellite.*

Beryl [p. 178, II—V].—Analyses of *beryl* by Hofmeister, (1 and 2) Rosenbach in Silesia, (3) Heubachthale:

		Si	Al	Be	Fe	Ca	Mg
1.	G.=2·65	65·34	21·01	11·32	1·21	0·26	0·12
2.		65·69	20·41	11·60	1·45	0·20	0·11
3.	G.=2·63	66·22	16·36	12·79	1·63	0·78	0·83

—*Jour. prakt. Chem.*, lxxvi, 1, in *Kopp's Jahresbericht*, 1859, 778.

Brucite [p. 133, I, II].—Ingelström has discovered this species at three localities near Filipstad in Wermland (Sweden). It occurs in small rounded masses in limestone. Three analyses gave:

		Mg	Fe	Ĥ	
G.=2·40	1.	68·80	3·35	28·80	= 100·95
	2.	66·80	3·60	29·50	= 99·90
	3.	68·51	3·83	27·67	= 100·01

The pure mineral contained no carbonic acid.—(*Kongl. Vetenskaps-Akad. Förhandlingar*, 1858, 187.)

Bucholzite.—See under *Sillimanite.*

Chlorotoid [p. 298, V].—T. Sterry Hunt describes the occurrence of *chloritoid* in the crystalline palæozoic schists of Notre Dame Mts. in Canada. At Brome it is found in a fine grained micaceous schist, also at Leeds and other localities in the Notre Dame Mts., it occurs in a similar rock in lamellar masses, rarely more than a quarter inch broad and one-eighth of an inch thick. In some specimens it forms spherical aggregations half an inch or more in diameter, composed of radiating lamellæ, and sometimes making up one-half of the rock. Cleavage of the mineral perfect in one direction, with two less distinct transverse cleavages. Lamellæ often curved, and not easily separable. H. =6. G. =5·13. Color, dark greenish-gray to

black, brilliant black on the surfaces of perfect cleavage; lustre, on cleavage surface vitreous, on cross fracture waxy; streak, greenish gray. Analysis of a specimen from Leeds:

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{H}$
26·30	37·10	25·92	0·93	3·66	6·10=100·01

This variety of chlorotoid has been known among geologists and mineralogists as *phyllite*, and Prof. Hunt shows in his article on this subject (given in this number of this Journal) that Thomson's phyllite from Massachusetts is most probably the same mineral. He further suggests that possibly the *ottrelite* of Haüy may also be a variety of chlorotoid, although this latter suggestion requires further investigation. The abundance of chlorotoid in the schists occurring over wide areas in Canada, and the Green Mountain range, has led Hunt to name these rocks *chlorotoid slate*.

Chrysolite [p. 184, I—IV, VI].—Mr. Edward A. Manice, of the Yale Scientific School, has analyzed the *olivine* found by Prof. O. P. Hubbard in a boulder of coarse basalt at Thetford, Vermont, with the following result:

$\ddot{S}i$	$\dot{F}e$	$\dot{M}g$
40·75	9·36	50·28 = 100·36

The oxygen of the silica, iron and magnesia is 21·73 : 2·08 : 20·11 or $\ddot{S}i : \dot{R}$ as 21·73 : 22·19, equal 1 : 1 or $(\dot{M}g, \dot{F}e)^3\ddot{S}i$.

Grains of green *chrysolite* washed from volcanic-sand found on the sea-shore near Vesuvius, analyzed by Kalle in Rammelsberg's Laboratory (*Pogg. Ann.*, cix, 568) contained $\ddot{S}i$ 40·35, $\dot{M}g$ 46·70, $\dot{F}e$ 12·34=99·39. This gives the formula $\dot{F}e^3\ddot{S}i + 7\dot{M}g^3\ddot{S}i$, corresponding very nearly with the composition of the chrysolite of the Pallas meteorite. Rammelsberg further examined the *white olivine* (Peridote bianco) of Mt. Somma. Occurs in crystals. Sp. gr.=3·243. The pulverized mineral gelatinizes, though with difficulty, with chlorhydric acid. $\ddot{S}i$ 42·41, $\dot{M}g$ 53·30, $\dot{F}e$ 2·33= 98·04. This is identical with the composition of *boltonite* as analyzed by Smith (Suppl. I) and the writer (Suppl. VII).

Clinochlore [p. 293, I, II, V].—Analyses of *clinochlore* from Achmatowsk by Struve (Kokscharow, *Min. Russlands*, iii, 236, in Kenngott's *Uebersicht*, 1859, 54):

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}g$	$\dot{C}a$	$\dot{H}$
31·64	13·54	5·83	36·20	0·05	12·74
31·52	13·96	6·12	35·68	0·05	12·67

agreeing very closely with the analyses by Craw and v. Kobell of the American and Bavarian mineral.

Copper p. 17, IV, VI].—Hautefeuille has discovered the presence of mercury in a specimen of argentiferous copper from Lake Superior.—(*Compt. Rend.*, xliii, 160, Kenngott, *Uebersicht*, 1859, 108.)

Cronstedite [p. 299].—Damour has reëxamined the *cronstedite* from Przibram, in Bohemia. The mineral is jet-black; opaque; streak dark to olive green; after heating the powdered mineral is perfectly black. H. above 3. G.=3·35. B.B. fuses to a black magnetic mass and with fluxes gives reactions for iron and manganese. Dissolves in acids, and on evaporation yields gelatinous silica. Composition:

$\ddot{S}i$	$\dot{F}e$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{H}$
21·39	29·08	33·52	1·01	4·02	9·76

[A determination of the sesquioxyd of iron in this mineral by v. Kobell gave 35·35 on which he recalculated one of Steinmann's analyses (see Min.). We add another analysis by Steinmann which has heretofore been overlooked (Schweig. Jour., xxxii, 69), giving it the amount of sesquioxyd of iron in accordance with Damour's results: $\ddot{S}i$ 22·83, $\ddot{F}e$ 29·08, $\dot{F}e$ 31·44, $\dot{M}n$ 2·43, $\dot{M}g$ 3·25, $\dot{H}$ 10·70=100·73. Damour gives the formula $(\dot{F}e, \dot{M}n, \dot{M}g)^6\ddot{S}i + \ddot{F}e^2\ddot{S}i + 6\dot{H}$ or $(\dot{R}^9, \ddot{F}e)\ddot{S}i + 3\dot{H}$.—G.J.B.]

Darwinite.—See *Whitneyite*.

Davyne.—See *Nepheline*.

DIALLOGITE [p. 446, III, VII].—The variety of this mineral called Himbeerspath, occurring at Oberneisen gave E. Hildebrand on analysis:

C̄	Mn	Ca	Mg	Fe	
38·94	55·32	2·99	2·07	0·61	= 99·84

DIANITE.—Von Kobell has given this name to a variety of what has heretofore been considered as tantalite, from Tammela in Finland. The specific gravity is 5·5, while that of the tantalite analyzed by Rose, Jacobson, and others varies from 7·38—7·5. The color of the streak blackish-gray; that of the tantalite from Tammela analyzed by Jacobson was dark brownish-red. In other respects *dianite* corresponds perfectly in physical characters with tantalite. Von Kobell, however, finds it to contain a new metallic acid belonging to the same group as tantalic and columbic acids, this he calls *dianic acid*, and the author has also discovered this new acid in euxenite, æschinite and samarskite. For a description of the chemical properties of this acid see this Jour., [2], xxx, 124, and *Bull. der Akad. der Wissenschaften*, March 10, 1860 (Munich).

EPIDOTE [p. 206, II—VII].—R. Hermann has published a continuation of his researches on this species (*Jour. prakt. Chem.*, lxxviii, 295). We quote only the new analyses; the paper is mostly taken up with a discussion of the author's views and objections to the hypotheses advanced by Scheerer.

	Si	Al	Fe	Fe	Ca	Mg	Ign.	
1. Bourg d'Oisans,	G. 3·42.	38·00	20·87	15·06	1·90	21·93	—	2·08— 99·84[a]
2. Arendal,	G. 3·37.	37·32	22·85	11·56	1·86	22·03	0·77	2·93— 99·31
3. "	G. 3·49.	36·79	21·24	12·96	5·20	21·27	—	2·86—100·32
4. Achmatowsk,	G. 3·41.	40·27	20·08	14·22	2·39	21·61	0·53	0·16— 99·26[a]
5. Sillböhle,	G. 3·45.	39·67	18·55	14·31	3·25	20·53	1·62	1·23 Na 0·52—99·68[a]
6. Traversella,	G. 3·47.	40·08	16·91	15·93	1·44	19·11	4·97	1·20— 99·64

([a]) with trace Mn.

For a memoir on the crystalline form of *epidote* see v. Zepharovich in *Ber. Wien Akad.*, xxxiv, 480.

FAUJASITE [p. 323].—A. Knop shows from the optical properties of this mineral that it belongs to the *monometric* and not to the dimetric system, in which it has heretofore been classed by many mineralogists.—(*Ann. Chem. Pharm.*, cxi, 375.)

FELDSPAR [p. 228, I—III].—The glassy feldspar from the trachyte of Drachenfels on the Rhine gave Rammelsberg (*Zeitsch. d. deutschen geolog. Gesellschaft*, xi, 437):

Si	Al	Fe	K	Na	Ca	Mg	Ign.	
65·87	18·53	*tr.*	10·32	3·42	0·95	0·39	0·44	=99·92

Rammelsberg considers it an isomorphous mixture of a soda and potash orthoclase. For analyses of the feldspar of the Norwegian zircon-syenite, see *Pogg. Ann.*, cviii, 425.

A. Mitscherlich has found baryta as a constituent of the feldspar from Hohenfels, Rieden, Kempenich, Rockesckill and in the *adularia* from St. Gotthard in quantities varying from 0·45 to 2·33 pr. ct.—(*Jour. prakt. Chem.*, lxxxi, 114.

FERGUSONITE [p. 350, III—VIII].—Nordenskiöld (Jour. prakt. Chem., lxxxi, 200,) gives a new analysis of the so-called *fergusonite* from Ytterby:

Cb	W	Y	Ca	U	Fe	H	
46·33	2·85[a]	39·80	3·15	1·12	0·70	6·44	= 100·39

([a]) with SnO_2.

The crystals are tetragonal, have a dark brown color, translucent on the edges H.=4·5–5. Sp. gr., 4·89. This differs very materially from the composition of the Greenland *fergusonite* as analyzed by Hartwall and Weber, that mineral having been found by these analysts to be anhydrous.

FIBROLITE.—See under *Sillimanite*.

FOURNETITE.—See *Tetrahedrite*.

GARNET [p. 194, I—VIII]—T. S. Hunt has discovered an emerald-green *garnet* at Oxford, Canada, in calcareous spar with millerite. It is massive, granular, or in transparent dodecahedrons resembling *uwarowite*, but is essentially a lime-alumina garnet, with 6 pr. ct. of chromium (this Journal, xxxi, 295).

A bright red manganese-alumina-garnet (spessartine) from Miask, analyzed by Lissenko, contained:

	$\dot{S}$	$\dot{\ddot{A}}l$	$\dot{M}n$	$\dot{F}e$	$\dot{C}a$	
G.=4·38.	36·30	17·48	30·60	14·32	0·51	=99·21

(Kokscharow, *Min. Russlands*, Kenngott, *Uebersicht*, 1859, 74.)

Gersdorffite [p. 58, VII, VIII].—A massive variety of this mineral from Pfingstwiese near Ems afforded Bergemann (*Jour. prakt. Chem.*, lxxix, 412):

S	As	Sb	Ni	Co	Fe	Cu	
21·51	33·25	0·62	22·79	1·64	16·64	4·01	=100·46

Excluding the copper it resembles the ferruginous variety of *gersdorffite* from Schladming in Styria analyzed by Pless.

Gibbsite [p. 134, 506, IV].—In noticing Rammelsberg's *Mineralchemie* we have already called attention to his treatment of this species. We here repeat, that American mineralogists, after a careful examination of a large number of specimens from Richmond, have been unable to obtain any such phosphate as described by Hermann. The chemical examinations made independently by four different chemists have confirmed the original result as given by Dr. Torrey, namely, that the mineral is a *hydrate of alumina* and even *purer* than the crystalline *hydrargillite* from the Urals.

We do not pretend to determine what Hermann examined, if it was really a phosphate, it most probably did not come from Richmond. We are, however, somewhat at loss to understand the following statement made in Hermann's paper on Gibbsite (*Jour. prakt. Chem.*, xlvii, 1). He says, that to the solution of the mineral in chlorhydric acid, he added a sufficient amount of tartaric acid to prevent precipitation of the alumina, then ammonia in excess, and finally sulphate of magnesia, without producing any precipitate of phosphate of magnesia and ammonia. This is rather a startling fact for a mineral in which he claims to have found from 11·90 to 37·62 pr. ct. of phosphoric acid. The majority of chemists would certainly conclude that this negative evidence was a sufficiently satisfactory demonstration of the absence of any considerable amount of phosphoric acid in Gibbsite. We also have been unable to obtain any reaction for phosphoric acid in *Gibbsite* by the above method, but we have never experienced any difficulty in detecting it by this means in *Wavellite* or phosphate of alumina.—G. J. B.

Gieseckite.—DesCloizeaux has confirmed the pseudomorphic character of this mineral by an examination of its optical properties.—(2e *Memoire*, 81.)

Gmelinite [p. 321].—Analysis of *gmelinite*, discovered by Gaudry near Pyrgo in the island of Cyprus, by Damour (Bullet. Soc. Géol. (2) xvi, 675, in Jahrb. Min., 1860, 78).

	$\ddot{S}i$	$\dot{\ddot{A}}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{H}$	
G.=2·07	46·37	19·55	5·26	5·51	0·78	22·00	=99·47

Gold [p. 7, I, II, V–VII].—For Dr. Genth's interesting observations on the occurrence of gold, see this Jour. [2], xxviii, 253. This paper has been translated and republished by Prof. Cotta in his "*Gangstudien*." Freiberg, 1860.

Graphite [p. 92, II–IV].—R. Hermann describes *graphite* from Ajaguss, in the Kirghese-Steppes, covering an extent of country equal to 10 square wersts, (1 werst = 3500 feet) occurring in an impure state in clay slate. This graphitic substance had a slaty structure and contained 40·55 graphite, 56·56 earthy matters, 2·80 water. Specific gravity = 2·60.—*Bull. d. Natur. de Moscou*, 1858, 530, Kenngott, *Uebersicht*, 1859, 105.

Harmotome [p. 323, V].—Analyses of *harmotome* from Andreasberg and Strontian, Rammelsberg (*Pogg. Ann.* cx, 624).

	$\ddot{S}i$	$\dot{\ddot{A}}l$	$\dot{B}a$	$\dot{K}$	$\dot{N}a$	$\dot{H}$	
1. Andreasberg,	48·49	16·35	20·08	2·07	*tr.*	13·00	= 99·99
2. Strontian,	47·52	16·94	20·25	1·00	1·09	13·45	=100·25

The oxygen ratio of $\dot{R}$, $\dot{\ddot{A}}l$, $\ddot{S}i$, $\dot{H}$, is as 1 : 3 : 10 : 5, taking silica as SiO_2, Rammelsberg gives the formula, $(\dot{B}a, \dot{K}, \dot{N}a)\ \ddot{S}i^2 + \dot{\ddot{A}}l\ \ddot{S}i^3 + 5\dot{H}$. For the relations between this species and *phillipsite* see the original memoir.

HARRISITE [III, IV].—Dr. Genth informs us that he has now in his collection a specimen of *harrisite* containing a nucleus of unaltered galena; thus substantiating the correctness of his conclusion that *harrisite is copper-glance pseudomorphous of galena.*

HAÜYNE [p. 230].—The blue transparent crystallized haüyne occurring with pyroxene and mica at Monte Somma, examined by Rammelsberg, (*Pogg. Ann.*, cix,) 577, gave in two analyses:

		$\ddot{S}$	$\dot{S}i$	$\dot{A}l$(a)	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	
G.=2·464	1.	11·25	34·04	undet.	10·89	11·47	5·21	
	2.	undet.	34·08	27·64	10·30	12·11	4·71	
Mean,		11·25	34·06	27·64	10·60	11·79	4·96	=100·30
Oxygen,		6·75	17·68	12·91	2·89	3·02	0·84	

(a) with traces of iron.

Subtracting from the oxygen of protoxyds one third of 6·75, or the amount necessary to combine with the $\ddot{S}$ present, we have 4·5 remainder, and the relation of $\dot{R}$, $\dot{A}l$, $\ddot{S}i$ will be as 1 : 3 : 4, or, taking silica as SiO_2, the formula $(\dot{R}+\dot{A}l)\ddot{S}i^2$. The oxygen of the protoxyds combined with $\ddot{S}$ is to that combined with $\ddot{S}i$ as 2·5 : 4·5 or 1 : 2, consequently the formula of the mineral may be expressed as $\dot{R}\ddot{S}+2(\dot{R}\ddot{S}i+\dot{A}l\ddot{S}i)$, or $\dot{R}\ddot{S}+\dot{R}^2\ddot{S}i+\dot{A}l^2\ddot{S}i^2=\ddot{S}$ 11·10, $\ddot{S}i$ 34·19, $\dot{A}l$ 28·51, $\dot{C}a$ 10·37, $\dot{N}a$ 11·48, $\dot{K}$ 4·35. Rammelsberg calls attention to G. Rose's observation that sodalite, haüyne, and nosean are isomorphous bodies—the silicate $(\dot{R}, \dot{A}l)\ddot{S}i^2$ occurs in all; some haüyne contains chlorine, as well as a certain amount of sodalite. The composition of the three minerals may be expressed as follows:

A. Sodalite = $NaCl+n(\dot{R}, \dot{A}l, \ddot{S}i^2)$
B. Haüyne = $\dot{R}\ddot{S}+n(\dot{R}, \dot{A}l, \ddot{S}i^2)$
C. Nosean = A $+n$ B

HEULANDITE [p. 330, IV].—A specimen of crystallized heulandite from Tiegerholm in Iceland analyzed by Rammelsberg (*Pogg. Ann.*, cx, 525) lost 1·91 pr. ct when the air-dried mineral was left for two days over sulphuric acid, and 13·5 additional on ignition, in all 15·48 pr. ct. Composition:

	$\ddot{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{K}$	$\dot{N}a$	$\dot{H}$	
	59·63	15·14	6·24	2·35	0·46	15·48	=99·30
Oxygen	30·95	7·07	1·78	0·40	0·12	13·74	

The ratio of $\dot{R} : \dot{A}l : \ddot{S}i : \dot{H}$ is nearly 1 : 3 : 12 : 6, considering the loss of 1·91 as hygroscopic water, the dry mineral contains $\ddot{S}i$ 60·97, $\dot{A}l$ 15·49, $\dot{C}a$ 6·38, $\dot{K}$ 2·40, $\dot{N}a$ 0·47, $\dot{H}$ 13·57=99·28, giving the oxygen ratio 1 : 3 : 12 : 5, the same as given in the Mineralogy. Rammelsberg, however, considers the former ratio to be more correct, as the zeolites easily part with a portion of water and 1·91 pr. ct. is too much to be called hygroscopic moisture. He gives the formula $(\dot{C}a, \dot{K}, \dot{N}a)^2\ddot{S}i^2+\dot{A}l^2\ddot{S}i^9+12\dot{H}$, which is the same general formula as stilbite, and in this view these minerals may be regarded as heteromorphous bodies. [It is deserving of notice that German authors use the name *stilbite* for the species which the English and American authorities call *heulandite*, and *desmine* for the mineral we designate as *stilbite*.—G. J. B.]

HJELMITE.—*Nordenskiöld, Jour. prakt. Chem.*, lxxxi, 202.—This name is proposed by Nordenskiöld for a new tantalate found at Kararfshof in Sweden. Crystalline form, undetermined. Color, jet black; lustre, metallic; fracture granular; H.=5·0; G.=5 82; streak, blackish-gray. B.B. decrepitates, falls to pieces and gives off water. In oxydizing flame becomes brown, but does not fuse; with salt of phosphorus dissolves to a bluish-green glass; with borax gives a colorless glass, which becomes opaque on flaming; with soda and charcoal yields metallic spangles. The minerals occur with *pyrophysalite, garnet, gadolinite*, in a rock composed of quartz, orthoclase, albite (?) and mica. Composition:

$\dot{T}a$	$\ddot{S}n$	$\dot{C}u$	$\dot{C}a$	$\dot{Y}$	$\dot{C}e$	$\dot{U}$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{H}$	
62·42	6·56(a)	0·10	4·26	5·19	1·07(b)	4·87	8·06	3·32	0·26	3·26	=99·37

(a) with $\dot{W}$. (b) with $\dot{L}a$ $\dot{D}i$.

HÖRNESITE.—Haidinger has given this name to a new hydrated arseniate of magnesia from the Banat, first observed and recognized as a new species by Dr. Kenngott, on a specimen in the Imperial Mineral Cabinet at Vienna. It occurs in talc-like, stellated, columnar and foliated snow-white pearly masses, in a gray coarsely granular calcite. Crystalline form, monoclinic. The foliæ are transparent, optically bi-axial; lustre on cleavage surface pearly; foliæ, flexible; H. = 0·5-1·0. G. = 2·474. According to von Hauer it is insoluble in water, but easily soluble in acids. Composition:

Ṁg	Ä̇s	Ḣ
24·54	46·33	29·07=99·94

giving exactly the formula $3\dot{M}g\,\dot{H}+\dot{H}^5\ddot{A}s$ or $\dot{M}g^2\ddot{A}s+8\dot{H}$, analogous to the general formula $\dot{R}^2\ddot{A}s+8\dot{H}$ for erythrine, annabergite, köttigite and symplesite.—(Kenngott, *Uebersicht*, 1859, 17.)

HYDROMAGNESITE [456].—P. Meyer describes an impure variety of hydromagnesite as occurring at Kaiserstuhl in Baden.—(*Ann. der Chem. und Phar.*, cxv, 129.)

KAOLIN [p. 249, V].—Analysis by A. Knop in *Jahrbuch für Mineralogie*, 1859 573:

S̈i	Ä̇l	K̇	Ḣ
49·92	35·23	*tr.*	14·85=100·00

KERAMOHALITE [p. 382].—Analysis of the so-called *keramohalite* from Maderan by Schweizer (Kenngott, *Uebersicht*, 1859, 12):

S̈	Ä̇l	Ṁg	Ṁn	Ḟe	K̇	Ċu	Ċa	Insol.	Cl	Ḣ[a]
35·96	10·55	3·74	2·51	1·06	0·58	0·22	0·27	1·12	*tr.*	44·26

[a] With some ammmonia.

Appears from Schweizer's experiments to be a mixture of alum, with (Ṁg, Ṁn, Ḟe) S̈ &c. Kenngott shows that Stromeyer's *mangan-magnesia-alum* may be a similar mixture.

LABRADORITE [p, 237, VII, VIII].—A white feldspar from Radauthal in the Harz examined by Rammelsberg contained:

	S̈i	Ä̇l	Ċa	Ṁg	Ṅa	K̇	Ign.
G.=2·817.	51·00	29·51	11·29	0·28	3·14	2·09	2·48=99·79

Is essentially *labradorite*.—(*Zeitschr. der deutschen geolog. Gesellsch.*, xi, 101, in Kopp's *Jahresbericht*, 1859, 785.

LAPIS-LAZULI [p. 229, V, VI].—Bergeron has described a variety of lapis-lazuli from Coquimbo, Chili, which phosphoresced strongly on heating.—(*Bull. de la Soc. Géologique*, [2], xvii, 432.)

LEAD [p. 17, III, IV].—C. v. Reichenbach has found native lead in small globules in a variety of basaltic tufa at Rautenberg in northern Moravia.—(*Verhandl. d. k. k. geolog. Reichsanstalt*, in Kopp's *Jahresbericht*, 1859, 769.)

LEUCITE [p. 231, III, V, VI].—Bergemann (*Jour. prakt. Chem.*, lxxx, 418) describes a pseudomorph of *leucite* from Oberwiesenthal which occurs in perfect icositetrahedrons; H. = 5·5; Sp. gr. = 2·5616. B.B. acts like orthoclase; partially decomposed by prolonged digestion in chlorhydric acid, in one case 5·94 pr. ct. was taken up. Composition of the whole mass after ignition:

S̈i	Ä̇l	Ḟe	Ṁg	K̇	Ṅa
60·46	22·11	1·98	1·22	13·53	0·52=99·82

Loss by ignition 1·22 pr. ct. The anhydrous mineral has the oxygen ratio 1 : 3·1 : 9·4 or nearly that of an oligoclase, in which the soda is replaced by potash.

LIBETHENITE [p. 420, VIII].—This species occurs at the "Mercedes" mine near Coquimbo associated with tagilite and limonite. It has a dark olive-green color and a resinous or waxy surface. Composition, according to F. Field (*Chem. Gazette*, June 15th, 1859.): Ċu 66·42, P̈ 29·31, Ḣ 3·74

LIEBENERITE.—DesCloizeaux has proved this mineral to be a pseudomorph by an examination of its optical properties. (2e *Memoire*, 80.)

MASCAGNINE.—On page 380 in the Mineralogy the formula for this species should read $\dot{N}H^4O$, $SO^3+\dot{H}$ instead of $2\dot{H}$.

MELACONITE [p. 109].—Kenngott (*Uebersicht*, 1859, 97) considers the crystals of this mineral to be pseudomorphs, a view already advocated by Teschmacher and Hayes, who suggested that the crystals might have been altered from the red-oxyd of copper. In opposition to this view, J. D. Whitney (see Min.) has shown that the crystals of cuprite occuring in the same vein with melaconite are uniformally *octohedral*, and in his opinion there is no sufficient reason for considering the crystals pseudomorphs.

MELANHYDRITE.—A new mineral found in a decomposed wacke from Schmelzerthal near Honnef on the Rhine; described by A. Krantz (*Verhandl. d. naturhist. Verein d. Rheinlande u. Westphalens*, xvi, 154). It is amorphous, occurs in irregular nodules, with conchoidal fracture; opaque; color, velvet-black to brownish-black; streak, blackish-brown. Does not fall to pieces when placed in water. In small fragments adheres to the tongue, G.=1·82. Analysis by Rammelsberg:

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{C}a$	$\dot{H}$
41·63	18·72	2·36	7·83	2·51	5·23	1·67	20·71=100·66

giving the formula $\dot{R}^3\ddot{S}i^2+2\dot{R}\ddot{S}i+12\dot{H}$ a composition near that of *palagonite*. (Kopp's *Jahresbericht*, 1859, 795.)

MELLITE [p. 475, II, VII].—Kokscharow describes two localities of this mineral in Russia, one at Malöwka in Government Tula, the other near Nertchinsk. The author gives new measurements, and an analysis of the specimens from Malöwka by J. v. Iljenkow.—(*Kokscharow Mat. Min. Russ.*, iii, 217, in Kenngott, *Uebersicht*, 1859, 119.)

	C	$\ddot{A}l$	$\dot{H}$
G.=1·597	21·18	14·20	44·16

The amount of carbon corresponds to 42·36 pr. ct. of mellitic acid, so that the results agree very closely with those obtained by Wöhler for specimens from Artern.

MICROCLINE [p. 242, VI, VII].—Scheerer has analyzed the feldspar in which the Norwegian *spreustein* is imbedded, and also the feldspar inclosed in the spreustein crystals. (Pogg., cviii, 430, in Kopp's *Jahresbericht*, 1859, 785). Anal. 1, is the outer, and 2, the enclosed feldspar.

		$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{K}$	$\dot{N}a$	Ign.	
G.=2·580	1.	66.03	19.17	0·31	0·20	6·96	6·83	0·21=	99·71
	2.	65·68	19·53	0·52	0·22	6·93	7·11	0·11=	100·10

This proves the feldspar matrix and the inclosed nucleus to be identical.

MONROLITE.—See under *Sillimanite*.

MONTICELLITE [p. 184].—An examination of this mineral by Rammelsberg (*Pogg. Ann.*, cix, 569), shows it to be distinct from chrysolite, a fact already indicated by Scacchi. The crystals analyzed had a yellowish-gray color. Sp. gr. 3·119. B.B. rounded only on the edges. The white powder is perfectly soluble in chlorhydric acid, but by heating gelatinizes. Composition;

	$\ddot{S}i$	$\dot{C}a$	$\dot{M}g$	$\dot{F}e$	
	37·89	34·92	22·04	5·61	=100·46
Oxygen,	19·67	9·98	8·82	1·24	

The oxygen ratio of the silica to the bases is 19·67 : 20·04 or 1 : 1 the same as in chrysolite, but the mineral is an isomorphous mixture of nearly equal parts of a silicate of lime, and silicate of magnesia, a portion of the latter being replaced by protoxyd of iron. Formula $\dot{C}a^2\ddot{S}i+(\frac{1}{2}\dot{M}g, \frac{1}{2}\dot{F}e)^2\ddot{S}i=\ddot{S}i$ 38·13, $\dot{C}a$ 34·65, $\dot{M}g$ 21·65, $\dot{F}e$ 5·57=100. Monticellite has the crystalline form, but not the cleavage of chrysolite. The composition is the same as that of Breithaupt's *batrachite*, and the latter must henceforth be classified under monticellite.

NACRITE.—See *Pholerite*.

NATROLITE [p. 327, VI, VII].—I have analyzed the natrolite recently found at Bergen-Hill, New Jersey, in the greenstone taken from the tunnel constructed by the New York and Erie Rail Road Company. Composition:

	$\ddot{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{H}$
G.= 2·249	47·31	26·77	0·41	15·44	0·35	9·84=100·12

showing it to be a very *pure natrolite* and not *thomsonite* as has been supposed by some mineralogists.—G. J. B.

NEPHELINE [p. 232, II, VIII].—The so-called *davyne* of Monticelli and Covelli placed in the mineralogy under nepheline, has recently been examined by Rammelsberg (*Pogg. Ann.*, cix, 579). The results obtained show davyne to differ from nepheline only in containing carbonate of lime. The crystalline form and cleavage are the same. Analyses:

	$\ddot{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{H}$	$\ddot{C}$
1.	38·76	28·10	9·32	15·72	1·10	1·96	5·63 = 99·59
2.	36·81	28·66	10·33	15·85	1·21	—	6·01
3.	36·96	28·31	9·39	—	—	—	6·04

If the carbonic acid and an equivalent amount of lime be subtracted in (1) we have $\ddot{S}i$ 45·41, $\dot{A}l$ 32·92, $\dot{C}a$ 1·97, $\dot{N}a$ 18·41, $\dot{K}$ 1·29. This is *nepheline*, and *davyne* may be regarded as a compound of carbonate of lime with *nepheline*, analogous to the composition of *cancrinite* as given by G. Rose. Cancrinite differs from davyne in that the amount of lime it contains is not sufficient to saturate the carbonic acid, and a portion of the carbonic acid must be assumed to be combined with soda. If these two minerals contained carbonic acid combined only with lime, and that in an invariable quantity, it could be assumed, as nepheline and carbonate of lime crystallize in the same form, that they might possibly be isomorphous mixtures. But Rammelsberg remarks that the varying amounts of lime and water (in some specs. $\dot{H}$ = 4 pr. ct.), make it more rational to consider both minerals as *nepheline* to a certain extent altered, by the introduction of carbonate of lime—an analogous decomposition being found in the scapolite group.

OTTRELITE.—See *Chlorotoid.*

PARALOGITE.—See *Scapolite.*

PECTOLITE [p. 305, II, III, V—VIII].—Ingleström has found *pectolite* at Langbaus Iron-Mine in Wermland, associated with chlorite and calcite. The mineral resembles asbestos. B.B. gives off water and fuses easily to a white enamel. A partial analysis gave—(*Jour. prakt. Chem.*, lxxxi, 396.)

$\ddot{S}i$	$\dot{C}a$	$\dot{N}a$ $\dot{K}^{(a)}$	$\dot{F}e$ $\dot{M}n$	$\dot{H}$
52·24	33·83	8·48	1·75	3·70

(*a*) by the loss.

PHILLIPSITE.—For remarks on the formula of, see Rammelsberg's article in *Pogg. Ann.*, cx, 622.

PHOLERITE [p. 251, VIII].—Mr. Richard Müller of Carlsruhe has communicated to Prof. Dana the following analysis of the so-called *nacrite* (Nakrit) recently found at the *Einigkeit* mine in Freiberg, Saxony. It occurs as a white, scaly crystalline aggregate in seams in gneiss and is associated with galena. Composition:

	$\ddot{S}i$	$\dot{A}l$	$\dot{H}$
	46·74	39·48	14·06
Oxygen,	24·92	18·45	12·97

The ratio of $\ddot{S}i$, $\dot{A}l$, $\dot{H}$, is as 4 : 3 : 2 and Müller gives the formula $\dot{A}l^3\ddot{S}i^4+6\dot{H}$ or $\dot{A}l, \ddot{S}i^3+2\dot{H}$. This is exactly the formula and composition found by Dr. Genth for the *pholerite* of Tamaqua, Pa. (this Jour., [2], xxviii, 251, and Suppl. VIII). Knop gives an analysis of an impure *pholerite* from Niederrabenstein in Jahrbuch für Mineralogie, 1859, 545.

PHOSPHOCHALCITE [p. 425, II, VI—VIII].—F. Field describes crystals from a mine near Coquimbo which have a turquoise blue-color and consist of

$\dot{C}u$	$\ddot{P}$	$\dot{C}a$	Ca Cl	$\dot{H}$
20·93	37·69	36·64	2·33	2·32 = 99·91

This he represents by the formula $2(\dot{C}u^5, \ddot{P}\dot{H}^3)+10(\dot{C}a^3, \ddot{P})+$Ca Cl or 2 atoms phosphocalcite, 10 atoms of tribasic phosphate of lime, and 1 atom of chlorid of cal-

cium. It occurs with a hydrous apatite, and it may be questionable whether the mineral is of uniform composition, there is however no doubt that the copper exists in the mineral as phosphate.—(*Chem. Gazette*, June 15th, 1859.)

PHYLLITE.—See *Chlorotoid.*

PINITOID; A. Knop (*Jahrb. Min.*, 1859, 558).—This new name has been given to a constituent of a rock occurring near Chemnitz, in Saxony. The rock consisted according to Knop, of quartz 58·06, mica 6·19, feldspar 8·44 and pinitoid 25·73=98·42. The *pinitoid* was dissolved out from the other species by sulphuric acid. It is a micro-crystalline mineral of a clayey and compact character. Color leek oil and grayish-green sometimes passing into white and red. G.=2·788, H.=2·5. It is a secondary product, and frequently occurs as pseudomorph after feldspar in decomposed porphyry. Composition:

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{K}$	$\dot{N}a$	$\dot{M}g$	$\dot{M}n$	$\dot{H}$
47·77	32·65	8·94	5·86	1·50	0·49	*tr*	4·19=101·40

This corresponds so closely to some of the analyses of the Saxon *pinite*, that it is to be regretted the author has embarrassed the science with a new name for a species already overloaded with synonyms.

PISANITE, *Kenngott, Uebersicht*, 1859, 10. This name is given by Kenngott to a cupreous variety of copperas from Turkey, analyzed by Pisani, noticed in the VIII Suppl. under *copperas.*

POLYCRASE [p. 357].—This species has been found by E. Zschau in the syenite of the Plauenische-Grund near Dresden, (Letter from Prof. Geinitz).

PROUSTITE [p. 78].—Analysis of *proustite* from Chile by F. Field (*Quar. Jour. Chem. Soc.*, xii, 12):

Ag	As	S
64·88	15·12	19·81=99·81

$3AgS, AsS_3$.

PYRARGYRITE [p. 77, IV].—Dark-red silver from Chile gave F. Field on analysis (*Quar. Jour. Chem. Soc.*, xii, 12):

Ag	Sb	S
59·01	53·16	17·45 = 99·62

$3AgS, SbS_3$.

PYROXENE [p. 158, I, II, V—VIII].—Crystals of pyroxene from Vesuvian lava of the eruption in 1631, analyzed by Wedding (*Kopp's Jahresbericht*, 1859, 780).

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{M}n$
48·86	8·63	2·73	4·54	20·62	14·01	*tr.* = 99·39

For observations on crystals of pyroxene from Warwick by vom Rath, see *Pogg. Ann.*, cxi, 263.

RUTILE [p. 120, V, VII].—Observations on the crystalline form of, see Kokscharow in Bull. Imp. Acad., St. Petersburg, i, 229. For Haidinger's remarks on the crystals of rutile from Graves' Mountain, Wien Akad. Abhand. January 5, 1860.

SARCOLITE [p. 200, II, VI).—Rammelsberg (*Pogg. Ann.* cix, 570) has made a complete chemical and crystallographic examination of this mineral, confirming the results given by Scacchi. Occurs in transparent dimetric octahedrons; color, reddish white; sp. gr. =2·932. Gelatinizes with chlorhydric acid. B.B. fuses to a white enamel.

	$\ddot{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{F}l$
1.	39·79	22·15	31·59	3·30	1·20	*tr.* = 98·03
2.	40·78	21·07	——	——	——	
3.	40·97	21·30	33·14	——	——	
Mean,	40·54	21·54	32·36	3·30	1·20	*tr.* = 98·91
Oxygen,	21·03	10·34	9·24	0·84	0·20	

The oxygen ratio of $\dot{R} : \dot{A}l : \ddot{S}i$ is as 1 : 1 : 2, the same as in garnet. Rammelsberg writes the formula $3(\dot{C}a, \dot{N}a, \dot{K})^2\ddot{S}i + \dot{A}l^2\ddot{S}i^2$. This analysis agrees with the results obtained by Scacchi (Min. p. 200). Sarcolite differs from humboldtilite in containing no magnesia, but the two minerals are nearly related and both have the same crystalline form.

SCAPOLITE [p. 201, I, II, V).—An examination of *paralogite* by Kokscharow proves it to be dimetric, confirming its identity with scapolite, as previously suggested by Kenngott (*Bull. Imp. Acad. de St. Petersbourg*, i, 229).

SERPENTINE [p. 282, I-VIII].—C. W. Hultmark has analyzed the *chrysotile* and *serpentine* from Sala, Sweden (*Jour. prakt. Chem.*, lxxix, 378).

		$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}g$	$\dot{M}n$	$\dot{H}$	$\dot{C}$
Chrysotile,	1.	41·03	1·43	1·25	42·31	*tr.*	13·72	*tr.*= 99·74
Serpentine,	2.	41·02	1·84	1·81	42·21	*tr.*	12·91	0·48=100·27

SILLIMANITE [p. 265, 513].—An optical examination of this mineral by DesCloizeaux has finally set at rest the question as to its relations to *kyanite*. Its optical properties prove it to be monoclinic, while kyanite is triclinic. With this species DesCloizeaux classes *fibrolite, bucholzite, xenolite, wörthite, bamlite* and *monrolite*. These all have the same optical properties, and they also differ from kyanite in density. A new analysis of sillimanite by Damour gave: (*Ann. des Mines* [5], xvi, 219.)

$\dot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}n$
39·06	59·53	1·42	0·28=100·28

from which DesCloizeaux concludes that the composition of sillimanite is $\dot{A}l^4\dot{S}i^3$, while kyanite is $\dot{A}l^2\dot{S}i^2$. To establish this point fully, will require an accurate examination, not only of the varieties of sillimanite, but also of fibrolite and other allied minerals.

SILVER [p. 15, III, IV].—A pseudomorph of *silver* after stephanite is described by G. vom Rath in *Pogg. Ann.*, cxi, 266.

SODALITE [p. 229, II, VI. VIII].—Two varieties of *sodalite* from Monte Somma have been analyzed by Rammelsberg (*Pogg. Ann.*, cix, 574). 1. *Colorless sodalite*, crystallizes in regular dodecahedrons and is associated with augite and mica; sp. gr. 2·136. 2. *Green sodalite*, is more rare, crystallizes in dodecahedrons with cubic planes, occurs in limestone with idocrase and nepheline. The analyses, calculating the chlorine as combined with sodium give:

	$\dot{S}i$	$\dot{A}l$	$\dot{N}a$	Cl	Na
1.	38·12	31·68	18·49	6·69	4·37=99.35
2.	38·76	34·62	21·18	2·55	1·67=98·78

The oxygen of the soda, alumina and silica in (1.) is 4·74 : 14·79 : 19·79; in (2.) 5·43 : 16·17 : 20·12, or very nearly 1 : 3 : 4 in both varieties.

Rammelsberg considers it as $(\dot{N}a+\dot{A}l)\dot{S}i^2$ combined with varying portions of chlorid of sodium. In (1.) the amount of sodium combined with the chlorine is equal to one third the soda existing as silicate, while in (2.) it is but one-ninth. The formulas given for the two varieties are:

1. $NaCl+3(\dot{N}a\dot{S}i+\dot{A}l\dot{S}i)=2NaCl+3(\dot{N}a^2\dot{S}i+\dot{A}l^2\dot{S}i^3)$
2. $NaCl+9(\dot{N}a\dot{S}i+\dot{A}l\dot{S}i)=2NaCl+9(\dot{N}a^3\dot{S}i+\dot{A}l^2\dot{S}i^3)$

The author argues that this double silicate is isomorphous with NaCl, as these substances combined in various proportions still have the same crystalline form. No. 1 has the same composition as the green sodalite from Greenland, and the blue variety from Brevig, Litchfield, Salem, and the Ilmen Mts.

Decomposed sodalite.—In the same memoir Rammelsberg also gives an analysis of a variety of weathered sodalite from Greenland. It occurs in opaque greenish dodecahedrons with black hornblende (arfvedsonite?). Decomposed by acids.

	$\dot{S}i$	$\dot{A}l$	$\dot{N}a$	$\dot{C}a$	Cl	$\dot{H}$ (loss).
	43·20	32·54	11·42	3·00	*tr.*	9·84
Oxygen	22·43	15·19	2·92	0·86		8·75

The ratio for $\dot{R}$, $\dot{A}l$, $\dot{S}i$, $\dot{H}$, is nearly 1 : 4 : 6 : 2, for which the author gives the formula $3\dot{R}\,\dot{S}i+2\dot{A}l^2\dot{S}i^3+6aq$, but it may be questionable whether this substance is homogeneous, and worthy of being considered as a distinct chemical compound.

STILPNOMELANE [p. 287, III, IV].—L. J. Ingleström (Jour. prakt. Chem., lxxxi, 397), has found *stilpnomelane* at Pen Mine in the Parish of Nordmark in Sweden, occurs in veins sometimes four inches in thickness; radiated, foliated, sometimes in globular masses intermingled with actinolite. Composition:

$\dot{S}i$	$\dot{F}e$	$\dot{A}l$	$\dot{M}g$	$\dot{H}$	
45·61	37·70	5·00	3·00	9 14	=100·45

[The author gives no proof that all the iron exists as protoxyd, thus leaving the composition of the mineral in doubt; we have previously drawn attention to the importance of ascertaining the oxydation of the iron in this mineral, when discussing its relations to the American *chalcodite* (this Jour. [2], xxv, 198).—G. J. B.]

TAGILITE [p. 426].—F. Field has analyzed *tagilite* from the "Mercedes" mine near Coquimbo, Chili. It is a beautiful fibrous variety, and occurs in considerable quantity associated with limonite. (Chem. Gazette, June 15th, 1859.)

$\dot{C}u$	$\dot{P}$	$\dot{H}$	
61·70	27·42	10·25	= 99·37

This gives the formula $\dot{C}u^4\,\dot{P} + 3\dot{H}$, the same as obtained by Hermann for the original specimens from Nischne Tagilsk.

TALC [p. 275, V].—A peculiar indurated variety of this species occurs in veins in gneiss at Bristol, Connecticut. It has a dark leek green color, and a greasy lustre and feel. H. = 2. G. = 2·82. Analysis by Dr. H. H. Lummis in the Laboratory of the Yale Scientific School:

$\dot{S}i$	$\dot{F}e$	$\dot{M}g$	$\dot{H}$
64·00	4·75	27·47	4·30

TETRADYMITE [p. 21, 512, I, VII].—Analysis of tetradymite from Cumberland England, by Rammelsberg (Min. Chemie, p. 4):

Bi	Te	S	
84·33	6·73	6·43	=97·49

equal to Bi^4+Te+S^4.

The telluret of bismuth from Field's Gold Mine near Dahlonega analyzed by Dr. C. T. Jackson, (this Jour. [2], xxvii, 39), and pronounced by him to be identical in composition with the Brazilian *bornite*, has been reëxamined by Dr. F. A. Genth with the following result: (*Mining Magazine*, (2), i, 358.)

		Bi	Te	Cu	Fe	Au, quartz, &c.	Se	
G. = 7·941	1.	50·83(a)	48·22	0·06	0·17	0·72	*tr.*	=100·00
	2.	50 97	47·25	0·06	0·25	0.80	*tr.*	= 99·33

(a) by the difference.

This agrees with the composition obtained by Dr. Genth for the *tetradymite* from Fluvanna Co., Virginia, and differs entirely from *bornite*, and the results of Dr. Jackson. This difference is explained by the fact that the methods of analysis employed by Dr. Jackson were unreliable, and consequently gave erroneous results; attention has been called to this point in an editorial notice in Erdmann's Journal für praktische Chemie, lxxix, 507, also in a similar notice in the Réperetoire de Chemie Pure, ii, 288, as well as by Dr. Genth (loc. cit.). Dr. Jackson has replied to Dr. Genth's criticisms (*Mining Magazine*, [2], i, 466) but inasmuch as no new facts or analyses are given, we must consider the Dahlonega *tetradymite* as essentially the same as that from Fluvanna Co., Virginia, and *not identical* with the Brazilian *bornite*.—G. J. B. [Since the above was written Dr. Genth has replied to Dr. Jackson, (*Mining Mag.*, (2), ii, 64, January,) showing the inaccuracies of the methods used by the latter.]

TETRAHEDRITE [p. 82, I, II, V].—*Ch. Mène* has described a new variety of tetrahedrite from Ardillats (Dept. de Rhône) France, which he calls *fournetite*. It occurs with galena in a quartzose porphyry. No physical characters, except density, are given. Its composition in three analyses was:

		Cu	Pb	S	Fe	As	Sb	Quartz.
1.	G = 4·319	26·50	9 90	19·00	2·50	6·60	18·20	16 70
2.	G. = 4·305	23·00	8·70	16·70	2·10	5·80	16·00	27·40
3.	G. = 4·320	26·80	10·50	19·20	2·50	6·70	18·70	15·20

rejecting the quartz gangue, the mean of the analyses gives Cu 32·00, Pb 12·00, S 23·00, Fe 3·00, As 8·00, Sb 22·0.—(*Comptes Rendus*, li, 463).

TRIPLITE [p. 408].—Bergemann describes a new locality for this mineral at Peilau in Silesia (*Jour. prakt. Chem.*, lxxix, 415). In thin splinters translucent. Color dark-brown almost black; streak, light liver-brown. H.=4. Sp. gr. 3·617. The surface of the mineral is frequently coated with oxyd of manganese. The pure mineral dissolves in chlorhydric acid without evolution of chlorine. Composition:

$\dot{P}$	Fe	$\dot{M}n$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\ddot{S}i$	Ign.
32·76	31·72	30·83	1·55	1·19	0·32	0·41	0·23	1·28 = 100·29

giving the formula $\dot{M}n^4\,\dot{P}+\dot{F}e^4\,\dot{P}$.

URANOPHANE.—*Websky* (*Zeitschc. d. deutsch. geol. Gesellschaft*, xi, 384. Kenngott, *Uebersicht*, 1859, 193), has given a more complete notice of this mineral before described by him (loc. cit., v, 427). It occurs in the copper mines at Kupferberg in Silesia. The mineral appears to be compact and amorphous, but the microscope reveals small acicular crystals which in druses have the form of flat hexagonal prisms. Color of crystals honey-yellow, of the compact variety siskin-green. Hardness somewhat less than 3. G.=2·78, specimen not perfectly pure. Lustre, vitreous to pearly. B.B. in glass tube gives reactions for water (alkaline), tellurium, selenium; in forceps, fuses with difficulty to a black glass, and gives a faint green color to the flame; on charcoal, becomes black, gives a reaction for selenium, antimony and bismuth; with fluxes, gives reactions for silica and uranium. Decomposed by both sulphuric and chlorhydric acids. Two analyses by Grundmann, (1) honey-yellow to siskin-green variety, (2) faint grayish green variety containing pitchblende as impurity:

	$\dot{H}$	$\ddot{S}i$	$\dot{X}l$	$\ddot{U}$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{P}$	Bi	Sb	Te	Fe	Pb	Cu[b]	Ag	S	
1.	14·11	15·81	5·65	49·84	4·69	1·35	1·71	0·12	1·73	1·46	0·43	0·57	0·29	0·21	0·11	1·66	= 99·74
2.	12·19	11·19	2·80	54·23[a]	3·58	1·19	0·80	0·05	1·77	1·86	0·22	0·89	0·38	5·24	?	3·96	= 100·34

(*a*) with some $\ddot{U}\,\ddot{U}$. (*b*) with some $\dot{C}u$.

after subtracting from (1) 0·81 chalcolite, 0·13 argentite, 0·23 covelline, 0·33 galena, 1·21 iron-pyrites, 1·19 tetradymite, 1·29 bismuth-glance, 0·02 sulphur, there remains, according to Websky, for the composition of *uranophane:*

$\dot{H}$	$\ddot{S}i$	$\dot{X}l$	$\ddot{U}$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$
13·99	15·81	5·61	49·33	4·69	1·35	1·71

for which he gives the formula $3(\dot{H}^2\ddot{S}i)+5(\ddot{U}^2\ddot{S}i)+36\dot{H}$.

[The mineral is undoubtedly a secondary product, and one may reasonably question its constancy of composition, and its right to be considered a distinct species.—G. J. B.]

VERMICULITE? [p. 292].—In the year 1851 Mr. W. W. Jefferis found near the clinochlore locality at Westchester, Pennsylvania, a peculiar bronzy yellow micaceous mineral, which on examination proved to be optically-biaxial with a low angle, resembling phlogopite, and it has for some years been circulated among mineralogists as a variety of phlogopite.

An examination of this substance made by Prof. J. Lawrence Smith and myself in 1853, showed its composition to be near that of chlorite, and it was considered by us to be a weathered chlorite, although our results were never published. My attention has since been called to this mineral by its peculiar pyrognostic properties. When a fragment of it is heated in the flame of a spirit lamp even without the aid of the blowpipe, it exfoliates in a most remarkable manner swelling up to fifty or more times its original size, thus very much resembling *thermophyllite* and *vermiculite* and altogether differing from *chlorite* or *mica*.

According to a statement communicated to me by Mr. Jefferis, it occurs in a vein in the serpentine rocks fifty yards south of the clinochlore locality; the vein is about two feet wide, and is composed of plates and crystals thrown together in the most irregular manner. The crystals are so soft and friable when first taken out, that it is difficult to handle them, they will scarcely bear their own weight. It is also found in crystals in the soil near the locality. The crystals are six-sided prisms, with a mica like structure and a perfect basal cleavage, they vary form one to three inches in diameter and are sometimes an inch or more in thickness. Mr. Jefferis has

one large crystal measuring six by four inches. The mineral is optically biaxial; laminæ less flexible than chlorite, almost brittle; color, brownish-yellow, light-yellow by transmitted light. Specific gravity of the air-dried mineral about 2·30. Hardness, between gypsum and common salt. B.B. in forceps exfoliates and becomes pearly white and opaque, and on prolonged heating fuses to a dark gray mass. In closed tube exfoliates, frequently bursting the heated tube, and gives off water which reacts alkaline. With the fluxes gives reactions for silica and iron. Decomposed by chlorhydric acid. The air-dried mineral lost 4·19 pr. ct. in weight by drying in a sulphuric acid desiccator, and 3·74 pr. ct. additional when dried at 100° C.: heated in an air-bath to 220° C. it lost 4·17 pr. ct., but between 220° and 300° C. the loss was scarcely appreciable, and maintained at the latter temperature for half an hour it suffered no farther diminution in weight; at a full red-heat over a blast-lamp it lost 5·85 pr. ct., making in all 17·95 pr. ct. Assuming the amount lost by drying over sulphuric acid to have been hygroscopic moisture, we have 13·76 pr. ct. of water contained in the mineral. It is difficult to determine what amount of water should be included as essential, but it is perhaps safest to take the mineral as dried over sulphuric acid. For analysis the mineral was decomposed by fusion with carbonate of soda—the state of oxydation of the iron was determined by dissolving a separate portion in chlorhydric acid in an atmosphere of carbonic acid, and subsequent titration with permanganate of potash—the alkalies were estimated by Smith's method. Composition:

$\dot{Si}$	$\dot{Al}$	$\dot{Fe}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$	
37·10	17·57	10·54	1·26	0·56	19·65	0·43	*tr.*	13·76	= 100·87

Other analyses made in 1853 by Prof. Smith and myself gave similar results. The iron in the mineral has undoubtedly been partially oxydized by weathering, many of the crystals are impure from infiltration of foreign matter between the laminæ and they are quite friable from exposure. It belongs to the chlorite section of magnesian hydrous silicates and in view of its pyrognostic properties we refer it with a query to vermiculite, which its chemical composition approximates. The great difficulty of obtaining pure vermiculite in sufficient quantity for analysis has thus far prevented me from reëxamining it, in fact I have delayed publishing my results on the Weschester mineral for more than two years, hoping thereby to be able to determine more fully its relations to this species. The oxygen ratio for the $\dot{Si}$, $\dot{R}$, $\dot{R}$, H as calculated from the analysis is as 19·89 : 11·36 : 8·36 : 11·23 or 7 : 4 : 3 : 4 equal to $3\dot{R}^3\dot{Si}+4\dot{R}\dot{Si}+12\dot{H}$ or the more general expression $(\dot{R}^3\dot{R})\dot{Si}+Aq$. The mineral is however so much altered by exposure, and so liable to impurities from infiltration of foreign matter, that it is very unsafe to draw any conclusion from the analyses, further than to refer it in a general way to the chlorite group near chlorite and vermiculite. The chief object in mentioning it here, is to call attention to its remarkable pyrognostic properties. The exfoliation in heating is not due to the escape of hygroscopic moisture, as it does not take place to any considerable degree until the mineral is exposed to a temperature above 300° C.—G. J. B.

WATER [p. 110, VIII].—L. Dufour has found the density of ice 0° C., to be 0·9175. —(*Comptes Rendus*, l, 1039.)

WHITNEYITE [VII].—D. Forbes has described (*L. E. & D. Phil. Mag.*, (4), xx, 423,) under the name *darwinite*, an arsenid of copper which is identical in physical and chemical properties with Genth's *whitneyite*. It is stated to occur in veins near Potrero Grande near Copiapo, Chile. It is massive, without cleavage, rather brittle, but may be distinctly impressed by the hammer; fracture uneven; lustre metallic; color of freshly-fractured surface dark silver-grey, on exposure dirty bronze-yellow; streak metalic, silver-grey; opaque. H. = 3.5. G. = 8·64. B.B. gives reactions for copper and arsenic with trace of silver. Composition:

	1.	2.	3.	4.
Cu	88·35	88·07	88·11	88·02
Ag	0·38	0·24	0·08	0·42
As	11·27	11·39	11·81	11·56

[These results leave no doubt as to the identity of the mineral with *whitneyite* (see Sup. VIII.) for which Genth obtained Cu 88·07, As 11·81, Ag and insol. 0·33 = 100·21.—G. J. B.]

WÖHLERITE.—For a memior on the crystalline form and optical properties of, see DesCloizeaux, (*Ann. des Mines* [5], xvi, 229).

WOLFRAM [p. 351, I—III, IV, VIII].—An interesting variety of this species is described by Dr. F. A. Genth (*Mining Magazine*, [2], i, 359). It occurs associated with quartz and mica, about 1½ miles from St. Francis River, St. Francis Co., Missouri; it is said to have been found in considerable quantities. Crystalline and cleavable parallel to the brachydiagonal; color, brownish-black; lustre, sub-metallic; streak, cinnamon-brown; Sp. gr. 6·67. Analyses by G. J. Pöpplein; (1) Decomposed by fusion with carbonate of soda, (2) by chlorhydric acid:

	$\dddot{W}$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$
1.	75·29	5·69	19·02	1·13 = 101·13
2.	75·52	undet.	19·73	undet. ———

The oxygen ratio of $\dddot{W}$, $\dot{F}e$, $\dot{M}n$, $\dot{C}a$, is 15·56 : 1·26 : 4·28 : 0·32, giving a new type of this mineral with the formula $\dot{F}e\ \dddot{W} + 4\dot{M}n\ \dddot{W}$.

XENOLITE.—See under *Sillimanite*.

YTTROTANTALITE [p. 359, IV].—In a memoir (*Jour. prakt. Chem.*, lxxxi, 193) on the chemical and crystallographic characters of the tantalates and columbates of yttria, Nordenskiöld gives a new analysis of *yttrotantalite* and points out the isomorphism of this mineral with polymignite and polycrase. The new analysis of the black variety of yttrotantalite gave:

$\ddot{T}a$	$\dddot{W}$	$\dddot{Y}t$	$\dot{C}a$	$\dot{F}e$	$\dot{U}$	$\dot{C}u$	$\dot{H}$
56·56	3·87	19·56	4·27	8·90	0·82	*tr.*	6·68 = 100·66

ZINC [VII].—According to G. Ulrich, native *zinc* has been found in basalt near Victoria in Australia. The specimen found weighed 4½ ounces, and was incrusted with smithsonite and aragonite, and a trace of cobalt bloom. Another locality is described by L. Becker as occurring in the gold washings of the Mitta river.—(*Kenngott, Uebersicht*, 1859, 108.)

ZINCITE [p. 110, II, III].—W. P. Blake has described and analyzed a very pure variety of this mineral from Franklin. It has a much brighter and clearer color than the ordinary red-oxyd, more nearly resembling crocoisite or realgar. It is transparent, orange yellow, has a distinct cleavage parallel to the vertical axis of a hexagonal prism, and also a basal cleavage, the latter being free from the black layers which separate the laminæ of the ordinary oxyd. In the specimen described there were several slender hexagonal prisms partially imbedded in a white enamel-like crust, the result of the weathering of the mass. H.=4—4·5. G.=5·684 (at 60°F.) Composition: (*Mining Magazine*, (2), ii, 94.)

$\dot{Z}n$	$\dot{M}n$	Ign.
99·47	0·68	·23 = 100·38

ZOISITE [p. 211, IV].—DesCloizeaux has shown from the optical properties of this mineral that it is distinct from epidote, the former belonging to the monoclinic, while the latter has the triclinic form. (*Ann. des Mines*, [5], xvi, 219].

ZWIESELITE [p. 399].—The probable identity of this mineral with triplite is pointed out by Kenngott (*Uebersicht*, 1859, 30). The author shows that the identity of crystalline form and other physical properties is further supported by the similarity of chemical composition, and that *zwieselite* is but a variety of *triplite*.

ERRATA.

Pages 358, 359, 365, 366. For *chlorotoid* read *chloritoid*.

Page 360. The analysis of *diallogite* by Hildenbrand is from the Annalen der Chemie und Pharmacie, cxiv, 348.

ART. XXXIV.—*On the conversion of certain Conglomerates into Talcose and Micaceous Schists and Gneiss, by the Elongation, Flattening and Metamorphosis of the Pebbles and the Cement;* by Prof. EDWARD HITCHCOCK.

IT will be seen by the statements below that the subject of this paper arrested my attention nearly thirty years since. But it was only within two or three years that I began to realize its importance and resume its investigation in connection with my youngest son, Charles H. Hitchcock. Nor was it till within a few weeks that the locality, which more than any other shows the completion of the metamorphic process for which we contend, was discovered. If we are not mistaken, these facts have an important bearing upon that most difficult subject of geology—*Metamorphism*,—for they show most conclusively the plastic condition of this conglomerate and the associated schists and gneiss, subsequent to their original consolidation. Other strong arguments do, indeed, lead to the same conclusion: such as the change exhibited by the Azoic rocks from a mechanical to a crystalline condition, the complicated foldings and contortions of these rocks, the remarkable curvatures of the veins of granitic rocks; and the existence of superinduced structures, such as no mere mechanical forces could have produced. But I pass by all these proofs now, and present only that from the changes in certain conglomerates.

So far as my knowledge of geological literature extends, the facts, and some of the conclusions presented below, are mainly new; and this is the chief reason why I offer them to this Journal. Professor Sedgwick has, indeed, described joints that "have actually cut through the pebbles of quartzite and other hard masses which enter into the composition of the conglomerates." (*British Palæozoic Rocks*, p. xxxvi, *Introduction*.) But he does not describe the pebbles as elongated, and he calls the joints "*mechanical*," which epithet I am confident he would not apply to the joint in the Rhode Island or Vermont conglomerates. The same thing is described by Jukes, in his Manual of Geology, more fully. He also notices as an effect of cleavage, the "distortion of fossils and other small bodies imbedded in the rocks, lengthening and pulling them in the direction of the cleavage and contracting them in the opposite direction." These facts, first noticed by Prof. John Phillips, have been used by Messrs. Sharpe, Sorby, and others, to sustain the hypothesis of the production of cleavage by "the action of great forces of compression, squeezing the particles of rock in one direction and lengthening them in the opposite." The facts which are presented in this paper harmonize with these views and lead to generalizations still higher, especially to the position so ably defended by Scrope, Beaumont,

Scheerer and Hunt, of the plastic condition of all the deep seated rocks since their original consolidation, and showing us how rocks mechanically formed are sometimes converted into schists, with entire changes of mineral character. Admitting these conclusions, the whole subject of metamorphism becomes comparatively easy and full of interest. This affords no small relief to one, who, like myself, has been for years perplexed and confounded in studying the highly metamorphic rocks of the Green mountains.

Doubtless many geologists will demur at my conclusions, as I should have done without visiting the localities. I can ask them only to suspend their judgment till they have seen the rocks which I describe, especially those at Newport and at Plymouth. If they shall then propose any more rational theory, I hope I shall be willing and thankful to receive it.

With these preliminary remarks I proceed to the details. We give them as proving and illustrating the following statement, and essentially in the language we shall use in our Report on the Geology of Vermont.

We have found striking examples where the pebbles of conglomerates have been elongated and flattened so as at length to be converted into the silicious laminæ of the schists and gneiss and the cement into mica, talc, and feldspar.

In a Report on the Geology of Massachusetts made by me in the year 1833 a singular conglomerate was described near Newport R. I.:—"composed of elongated rounded nodules of quartz rock passing into mica slate, with a cement of Talcose slate, the nodules varying from the size of a pigeon's egg, to four and even six feet in their longest diameter, and so arranged that their longest diameters are uniformally parallel to one another, lying in a north and south direction. The conglomerate is divided by fissures running east and west vertical to the horizon, and parallel to one another from ten to twenty feet apart. These fissures divide the thick masses of comglomerate so perfectly that they seem as if cut through by the sword of some Titan. The nodules through which the fissure passes, are divided very neatly and the parts present even surfaces, so as to give the rock a quite peculiar aspect."

These facts were repeated in the subsequent Reports upon Massachusetts in 1835 and 1841. But it was not until we found an analagous conglomerate along nearly the whole western side of the Green mountains that the special bearing of the facts above mentioned upon metamorphism occurred to us. Myself and son then (1859) visited Newport to get a clearer view of the facts in the hope that they would help us better to unravel the intricacies of the Vermont conglomerates. That same year I read before the Amer. Assoc. for Adv. of Sci., a paper on the subject, as it was developed at Newport and at E. Wallingford, where an interesting locality had been discovered by Mr. Hager, another of my assistants in the geological survey of Vermont.

In 1860 my son brought the subject again before the Association for Adv. of Sci. But it was not until after that time that the last link in the argument was supplied by a visit to a locality in Plymouth, Vt., which was also discovered by A. D. Hager. We will now try to state the facts and conclusions as they have been gradually worked out by us. If any should wish to verify our statements and see the force of our reasoning, we advise them to visit the different localities in the order in which we describe them. For the processes began at Newport, seem to be carried to the conclusion in Vermont.

Perhaps the best exposure of the Rhode Island conglomerate is at the well known 'Purgatory,' two and a half miles east of Newport, and within the limits of Middletown. According to the paper of C. H. Hitchcock read before the Am. Association in Aug., 1860, the belt of conglomerate commences a little south of Purgatory, is a mile wide with interstratified belts of slates, and extends N. 30° E. probably as far as Sandy Point, in Portsmouth some 5½ miles. It shows several folds, is underlaid by a gritty schist or sandstone, and itself underlies the coal measures.

"It is a coarse conglomerate, composed of elongated and flattened pebbles, from the smallest size, to bowlders nearly 12 feet long, cemented by a meagre amount of talcose schist, or sandstone," with numerous small disseminated crystals of magnetite. The pebbles are mostly a fine-grained, or compact quartz rock, which when partly decomposed appears like sandstone; not unfrequently the pebbles seem to pass into an imperfect mica schist, and show lamination. A few of them are gneiss, and probably granite, and occasionally hornblende rock. In their shortest diameter they rarely exceed a foot, while in length, one, two, and three feet are very common, and a few may be seen from 4 to 6, and one, at least, is as long as 12 feet. The following facts as to the pebbles, are of the most interest:

1. They are often very much elongated in the direction of the strike; 2. They are flattened, but not so strikingly as they are elongated; 3. They are indented often deeply by one being pressed into another; 4. They are sometimes a good deal bent, occasionally in two directions; 5. They are cut across by parallel joints or fissures, varying in distance from each other from one or two inches to many feet. The most distinct of these joints, which are a rod or two apart; are perpendicular to the horizon, and nearly at right angles to the strike, and make a clean cut from top to bottom of hills 30 or 40 feet high. Abrading agencies have often removed the rock on one side of these joints, or between two of them, so as to leave walls of pebbles smoothly cut in two; the whole appearing like a pile of wood neatly sawed. Acres of such walls may be seen in the vicinity of 'Purgatory.' Often the surface of the pebbles thus cut through is not only perfectly even, but smooth and seemingly polished. Yet the two parts

of the pebbles thus cut off, perfectly correspond, and one part has never been made to slip over the other. In some minor joints single pebbles are not entirely cut off, but are sometimes drawn out of their beds at one end where the rock is separated, and remain projecting above the cleared surface. These joints do not always extend through the whole rock.

We should be glad to introduce here many sketches of specimens illustrating these statements. But one or two must suffice:—

Fig. 1 will give some idea of an elongated pebble from Newport, which is 10 inches long and 3 inches across its broadest part.

1.

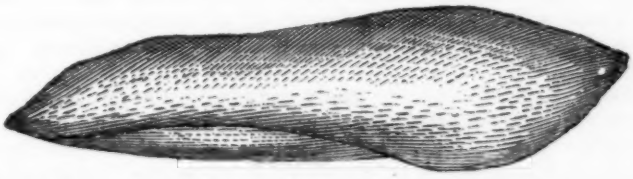
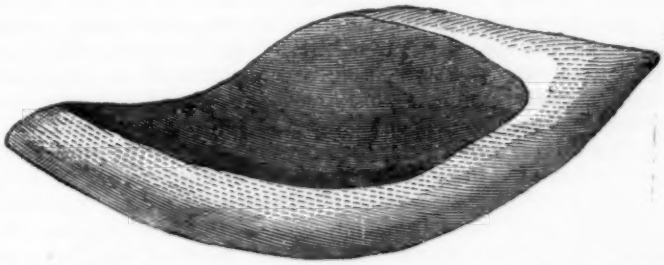


Fig. 2 shows a pebble 8 inches long with a deep indentation.

2.



Perhaps I ought to add that sometimes the elongated pebbles partially or wholly lose their rounded form at the ends, and begin to assume a foliated or schistose aspect, and to be somewhat blended with the talcose or micaceous cement. This though not general, is frequently the case.

From these facts we could hardly avoid drawing the following conclusions:

1. This rock was once a conglomerate of the usual character, except in the great abundance of the pebbles, and it has subsequently experienced great metamorphoses making the cement crystalline and schistose, and elongating and flattening the pebbles. 2. The pebbles must have been in a state more or less plastic, when they are elongated, flattened and bent. If their shape has been thus altered, their plasticity must of course be

admitted; for the attempt to change their present form would result only in fracture and comminution. The degree of plasticity, however must have varied considerably; for some of them are scarcely flattened or elongated at all—and as has been stated, some are not cut off by the joints.

The neat and clean manner in which the pebbles have been generally severed by the joints, implies plasticity.

For though occasionally we meet with one that has a somewhat uneven surface, as if mechanically broken, such cases are rare. Whatever may be our theory of the agency that has formed the joints, the conviction is forced upon every observer that the materials must have been in a soft state after their original consolidation. There is no evidence that the opposite walls have slid upon one another at all, as the opposite parts of the pebbles coincide. It seems as if a huge saw or cleaver had done the work.

These proofs of plasticity apply essentially, though less forcibly to the micaceous and talcose cement which has also been cut across by these joints. Though generally small in quantity it sometimes forms layers of considerable thickness interstratified with the pebbles.

Some have imagined that the elongated, flattened, bent, and indented pebbles of this conglomerate may have been worn into their present shape and brought into a parallel arrangement by the mechanical attrition of waves and currents. We feel sure that an extensive and careful examination of the localities, and of beaches where shingle is now being formed, will convince any one that they cannot have had such an origin.

1. We do not believe that any beach can be found with pebbles that have anything more than a slight resemblance to those at Newport. Those somewhat elongated may indeed be found where they are derived from slate rocks. But nowhere does the attrition of pebbles against one another produce deep indentations, and leave the one neatly fitting into the other, nay, one bent partially around the other, as is the case at Newport. If these phenomena were produced by original attrition how strange that they should have such an extraordinary development on Rhode Island, while it is not marked enough in any other conglomerate in our country save in Vermont, to have arrested the attention of geologists.

2. The remarkable joints in this conglomerate prove that the pebbles have been in a plastic state, and since the strata have been much folded, and consequently subjected to strong lateral pressure, how could the pebbles have escaped compression and modification of form? A mass of the conglomerate when broken open along the line of strike, a good deal resembles a plug of tobacco, which has been rolled into lumps and then subjected to strong pressure, so that the lumps are distorted and made to conform to all the irregularities around them.

3. The force by which the pebbles were flattened and indented must have operated laterally, as would result from the plication of the strata; folds in which are frequent. If there was a great superincumbent pressure and less in the direction of the strike, the same lateral force might have elongated the pebbles. But perhaps there may have been also a horizontal curvature in the strata, to aid in the work, as we shall explain when we come to describe the Vermont localities. It may not, however, be easy to show how this compressing force has operated where rocks have been so folded and disturbed as around Newport, for the conglomerate is in juxtaposition with granite, which has exerted a powerful metamorphic influence on other strata there; but if we can show the results of the agency, our main object will be accomplished.

4. The phenomena of the joints in this rock, conduct us most naturally to some polar force as the chief agent in their production. Mere shrinkage could not have separated the pebbles as smoothly; much less could a strain from beneath have thus fractured them; for sometimes the joints are not more than two or three inches apart, and if we suppose one of them to have been the result of fracture, yet how is the other to be obtained in that manner? A simple inspection of the rock in place will satisfy any one that no mechanical agency is alone sufficient to explain these phenomena. We have been driven to the supposition of some polarizing force acting upon soft materials. If, as Sir John Herschel supposes, cleavage may have resulted from a sort of crystallization in plastic materials, why may not joints come into the same category? Why should the conclusions drawn from the experiments of Mr. Fox upon the lamination of plastic clay, by electric currents, be limited to cleavage?

5. The Newport conglomerate is probably only a special variety of the extensive deposit of highly silicious pudding-stone found so abundantly between Boston and Rhode Island. Both have the same geological position, we believe, and were the Roxbury conglomerate to be brought into a plastic state, and the pebbles elongated and flattened by pressure, we think the result would resemble the Newport conglomerate.

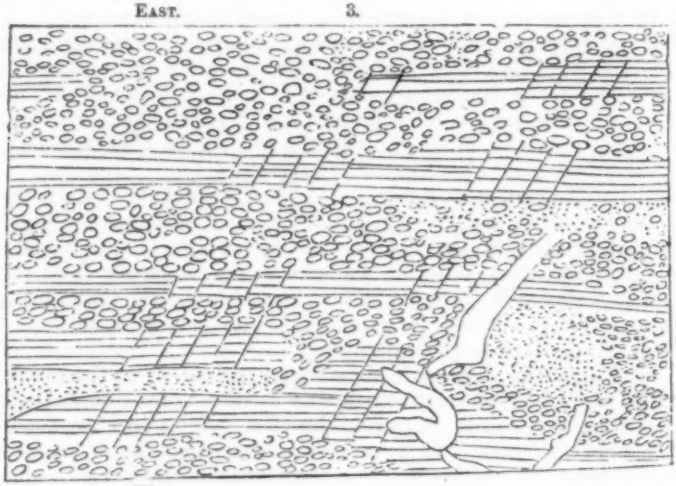
Thus far we are legitimately conducted, we think, by the Rhode Island rock. We are carried farther by the Vermont conglomerates, which we now proceed to describe. We select two localities, although doubtless many others might be found equally instructive. The rock occurs on both faces of the Green Mountains, and we can hardly doubt that it once formed a fold over the mountains, which denudation has swept away.

We have found this rock in connection with quartz rock, mica and talcose shists, and gneiss; sometimes merely in juxtaposition, as in the case of the quartz rocks, but sometimes interstratified. The conglomerates at the different localities may not

be identical as to geological age; yet we incline rather to the opinion, that quartz rocks, micaceous and talcose schist and gneiss, may be varieties of the same original rock, which metamorphism has sometimes converted into one and sometimes into others of the series. Quartz rock may be the residuum of certain silicates; the schists and gneiss are these silicates modified; any of these rocks, we think, might be formed out of the conglomerate under consideration, as we shall now endeavor to show. If so, we might perhaps find it in connection with them all, without implying a difference of age.

In the N.E. part of Wallingford, Vt., on the western slope of the Green Mts. on the hill north of David Hager's, is an interesting exhibition of the conglomerate. Numerous bowlders are scattered over the fields, which are instructive, but the embossed ledge half a mile north of Hager's is most so. It has been rounded and smoothed by the drift agency so as to show the pebbles and their alteration with the schists, very distinctly, as the following sketch of a portion of the ledge, taken by A. D. Hager, my assistant in the geological survey of Vermont, will evince. It will be seen that the schist often containing small pebbles or coarse grains of sand, is interstratified somewhat irregularly with the pebbles; just as we often see in the alluvial deposits, and in the sandstones that have not been metamorphosed. The drift striæ are quite distinct upon it, running southeasterly, as shown on the sketch, fig. 3.

EAST. 3.

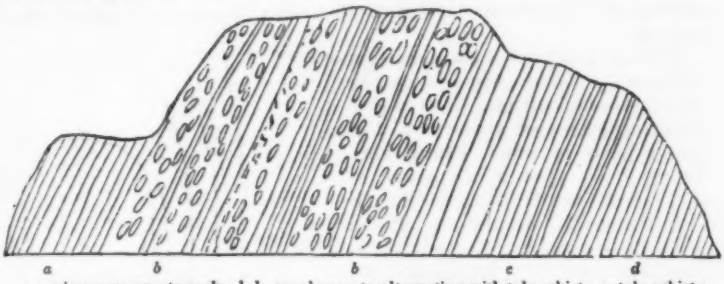


WEST.

The strike of these strata is about N.E. and S.W. and the dip 70° W., but it sometimes rises to 90° near by. To show its position in respect to a micaceous quartz rock, approaching micaceous schist, on the upper side, and to the Green mountain gneiss below it, we give the adjoining sketch, Fig. 4. These rocks constitute a single massive ledge,

with very few distinct strata-seams, and they seem as if only varieties of the same rock.

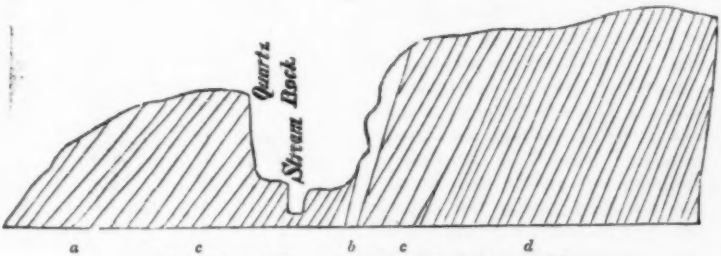
4.



a, micaceous quartz rock; *b*, *b*, conglomerate alternating with talc schist; *c*, talc schist; *d*, gneiss.

To show that the gneiss sometimes lies above the quartz and the schist, we give the following section, Fig. 5, only a few rods long, taken at an easily accessible locality, on the east side of the mountain; where, as we shall shortly see, the same rocks occur in juxtaposition. In the road from Ludlow to Mt. Holly, and near the line between the two towns, a small stream has cut a gorge, 40 or 50 feet deep, through a ledge of quartz rock. On the west side a trap dyke occupies a considerable part of the face of the rock, though more or less worn away. Talcose schist succeeds the quartz rock on the west side, dipping beneath it at a high angle. But on the east side, and lying upon the quartz at a less dip, is distinct gneiss, with more of feldspar than is usual in the Green mountain gneiss. The section below will give an idea of these facts, fig. 5.

5.



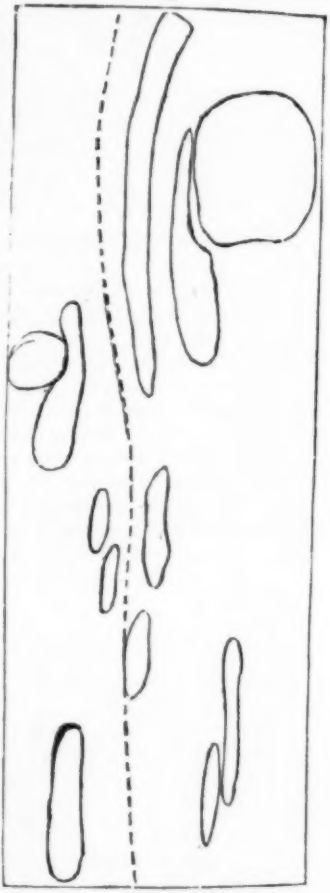
a, gneiss; *b*, trap dyke; *c*, *c*, quartz rock; *d*, talcose schists.

More than nine-tenths of the pebbles in the Wallingford conglomerates, are grey, somewhat granular, but often more or less hyaline quartz. White feldspar nodules are not uncommon. Quartz is sometimes disseminated through the feldspar, so as to form a sort of graphic granite. A few pebbles of distinct gneiss have been noticed. But it is not unusual for the micaceous cement to exhibit laminæ of feldspar, becoming, in fact, veritable gneiss; and perhaps the gneiss pebbles may all have thus originated. The most striking pebbles of feldspar, however, are seen in a finer variety of the rock, destitute of quartz pebbles, but showing small white rounded masses of feldspar, rarely over half an inch in diameter. We are of opinion that all the feldspar pebbles, as well as the narrow

strips of gneiss, are the result of metamorphism; that is, the pebbles were changed in mineral constitution, and the gneiss actually formed, by metamorphic processes. But we shall recur to this subject again in the sequel.

Most of the pebbles are somewhat elongated in the direction of the strike on a horizontal surface, so as to give them an egg-shaped appearance. But where joints or other fissures have exposed the edges of the strata at right angles to the strike the elongation flattening and bending of the pebbles, are much more striking, as the following outline, fig. 6, will show. Yet even here, a few pebbles appear not to have been at all modified in form:—two such are shown on the drawing. They seem not to have been plastic as the others were.

6.



Single pebbles sometimes show striking curvatures, as on fig. 7, where *a* represents a pebble ten inches long, and a little more than one inch wide, *b* shows a smaller one less curved, 5½ inches long, and half an inch wide.

A still more interesting case is shown in another boulder, a few feet long, represented imperfectly in fig. 8. Here the laminæ of the schists are bent considerably. On the inner side is a quartz pebble of considerable size, which is elongated and bent somewhat. But outwardly, the pebbles are so much flattened that they can hardly be distinguished from the quartzose laminæ of the rock. At the time this sketch was taken, we did not fully realize the important bearings it might have upon theory, and therefore we fear that it is not as minutely accurate as to every pebble, as could be desired. Still, the general facts above named are quite manifest, and these are all that are important.

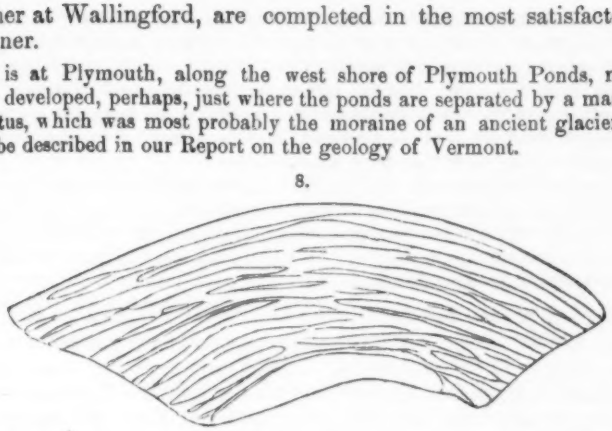
7.

The preceding facts would justify some inferences additional to those drawn from the Newport rock. But we will first describe another locality on the east side of the Green mountains, where the metamorphic processes, begun at Newport and carried still

farther at Wallingford, are completed in the most satisfactory manner.

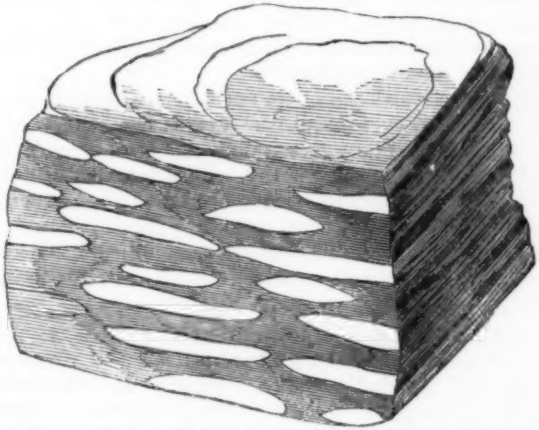
It is at Plymouth, along the west shore of Plymouth Ponds, most fully developed, perhaps, just where the ponds are separated by a mass of detritus, which was most probably the moraine of an ancient glacier, as will be described in our Report on the geology of Vermont.

8.



The schist, which here is decidedly talcose schist for the most part, and not far from some of the gold diggings, has an easterly dip; from 50° to 60°; and a direction a few degrees east of north. As the ledges crowd closely upon the road, a fine opportunity is presented of seeing the quartz pebbles that have not been much flattened on the exposed surfaces, having the aspect of a most decided conglomerate. Yet, if joints cross the rock, or if it be broken across, in the direction of the strike, the pebbles will for the most part, appear so flattened that they become almost len-

9.



ticular, or laminated. And if a fracture be made, or a joint occur, in a perpendicular direction, that is in the direction of the dip, the pebbles almost wholly disappear, or rather seem converted into the quartz laminæ of talcose schist. Both these facts are shown on fig. 9, which was copied

from one of the specimens obtained at this locality. Looking at one of these edges, we should have no hesitation in referring the rock to a highly quartzose variety of talcose schist. But looking at the other edge, we should have no doubt that the quartz laminæ are merely flattened and elongated pebbles. So strange and unexpected a fact leads the geologist to suspect that he may be deceived; but hundreds of specimens force him to the conclusion that he is not mistaken.

The quartz in this rock, both in Wallingford and Plymouth is generally white, or a light gray, and though sometimes granular, it approaches much nearer the hyaline variety, in most instances. It seems to be quite pure silex, rather than a silicate. In a few instances we find pebbles of granite, which are also flattened.

The suggestion has been made that what I regard as pebbles may be concretions. But the following facts seem to me to show this position to be untenable. 1. We have no other example of concretions formed of hyaline or granular quartz. 2. Concretions are never, as these nodules are, drawn out into the laminæ of schists. 3. Siliceous concretions, such as chalcedony, formed by gelatinous silex, are banded; but these nodules show no concentric structure. 4. Some of them consist of granite, gneiss, &c., which certainly never form concretions. 5. If these nodules are concretions, so are the pebbles of quartz and granite found loose in modified drift; or rather, no line of distinction can be drawn between the concretions and the pebbles.

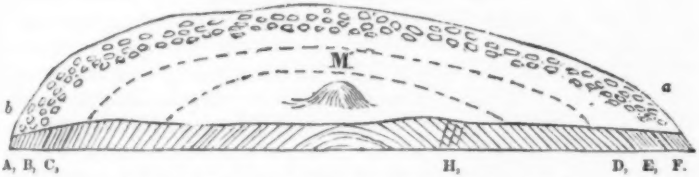
The thickness of the rock where the pebbles are indicated, is many hundred feet. Indeed, it may be much more, as I have not fully explored it. And if, as we suppose, the strata already described in connection with the conglomerate, are only that rock in an advanced state of metamorphism, the original thickness must have been very great.

We have ascertained, also, that the layers with pebbles extend as far south as Ludlow, though nearly converted there into mica schist; nor can we doubt but it may be traced much farther south and north, perhaps even the whole length of the Green mountains. At any rate, its occurrence on the opposite sides of that mountain at Wallingford and Plymouth, at points not much different from east and west of each other, leads to some interesting suggestions and conclusions. The distance between these two points is about ten and a half miles.

Myself and son, aided by the Senior Class of 1861, in Amherst College, have recently, (October, 1860), traversed this line, mostly on foot, and obtained as the result, the section below, fig. 10. The base of the section is the sea level, and the heights are laid off from the same scale, (about 13,000 feet to the inch), as the horizontal distance. This makes the Green mountains, (1390 feet above the ocean at Mt. Holly), appear of very diminutive size. But it is a true representation, except that the mountain for the sake of distinctness is a little too high. On both the flanks of the mountain, the dips are quite distinct, (they were measured

and the mean taken along the railroad from Ludlow to the summit as well as from the Plymouth Ponds). But in the central parts they are a good deal irregular. It will be seen that all the central portion of the mountain is gneiss of the peculiar kind known as the Green mountain gneiss. Above this lies, what has been called talcose schist, with which limestone is interstratified, and on the east side several beds of dark grey hyaline quartz, only a few feet thick. One of these beds, however, is snow-white. The upper part of the schist is the conglomerate already described, of a character so marked as not to be mistaken. At the west end we found several beds of limestone, but none of quartz. Beyond the conglomerate, however, and probably lying conformably upon it is an enormous development of granular quartz, which seems to have no counterpart on the east side of the mountain.

10.



In this section *a*, *b*, shows the present surface, *a* being Wallingford, and *b* Plymouth. From A to B we have the talcose conglomerate; from B to C, mainly gneiss with some schist, and at least three beds of limestone, from C to D, gneiss with several trap dykes at H, the summit level of the railroad; from D to E, gneiss with talcose schist and at least two beds of limestone, and several thin beds of quartz; from E to F, talcose conglomerate. This last rock, so distinct and peculiar, forms a good starting point for our reasoning. I think no geologist will doubt that it once mantled over the mountain with the subjacent strata as represented in the above section. True, we have not found all the subordinate beds of limestone and quartz to correspond on the two sides of the mountain. But there is a general correspondence. The beds of limestone, especially, may have extended originally over the arch of the mountain, although it is not common to find limestone beds as thin as these, with so great a lateral extension. As to the beds of quartz, if this be in nearly all cases a rock produced in the wet way, all we can say is, that circumstances may have been more favorable for its production on the east than on the west side of the crest of the mountain.

Taking this section as a fair representation of the Green mountains, several important inferences follow.

1. It shows the gneiss of the Green mountains, to form a great anticlinal fold not a synclinal fold, as some have supposed. 2. This gneiss underlies the talcose schist, the limestone, the quartz rock and the conglomerate. 3. All these latter rocks probably once mantled over the gneiss, though they have mostly disappeared from the eastern side, except the talcose schist. 4. We

get an approximate idea of the amount of erosion from this part of the Green mountains. We have flattened down the curve described by the strata originally, more than perhaps we ought to do, yet it runs almost twice as high as Mansfield mountain, which is shown on the section at M, and is the highest point in the chain. The erosion at Mt. Holly cannot have been less than 8000 feet, which is nearly six times as great as the present height of the mountain at the summit level of the railroad. 5. We see here how the schists and gneiss may be formed out of conglomerate. This is perhaps the most important inference, and therefore it will be dwelt upon more fully in the sequel.

We proceed now to draw some inferences from the facts detailed respecting the Vermont conglomerates, additional to those already given. The Vermont localities teach the same lessons as those of Rhode Island, but we think they develop other conclusions.

1. They show, we think, that the elongating and flattening force in Vermont must have operated most energetically in the direction of the dip, whereas in Rhode Island, it was most powerful in the direction of the strike. In the latter case it was as if two men had taken hold of the ends of a plastic mass, and pulled it out horizontally; but in Vermont it is as if one had stood at the top of a steep hill, and the other at the bottom. This is evident from the fact that when we look at the edges of the rock laid bare along the line of the dip, we see little more than the flattened edges of the pebbles in the form of laminæ, but if laid bare along the line of strike we see the scattered and even lenticular ends of the pebbles, as shown in fig. 9, already given. The fact however, that the pebbles are lenticular on the basset edges of the strata, shows that the whole force was not exerted in the direction of the dip. They were a good deal flattened horizontally, but never so vertically.

2. We think we can get a glimpse in Vermont of the mode in which the force acted to elongate and flatten the pebbles. We refer to the bowlder shown in fig. 8, where it is obvious that the bending of the rock, if it was plastic could produce that effect, because the outer portions must be extended over wider and wider spaces. Hence, as in the figure, a pebble on the interior part, might be only moderately extended while the outer ones were stretched almost into mere laminæ.

Apply now this principle to fig. 10, which shows the manner in which, as we suppose, the strata were folded over the top of the Green mountains. The effect would be to stretch them out more in the direction of the curve, or dip, than at right angles to it; although the strain would spread them in that direction also, to some extent, and it may be that the irregularities that must have accompanied such great movements as the folding up of a

mountain chain, would make the horizontal elongation in some places the greatest.

We do not assert that this explanation of the phenomena is the true one, but only that it shows one mode in which the process might have been performed. Whether any horizontal flexure can be found in the Rhode Island rock to explain the elongation there, we are unable to say, because the theory was not in our minds when we examined those rocks.

3. The facts detailed, disclose to us some of the modes in which the laminæ of the schists and of gneiss may have been produced. The first mode is by chemical agencies. Out of the cement of conglomerate these agencies have formed mica and talc, whose parallel structure was probably the result, mainly of pressure. We doubted for a time whether we could justly include gneiss among the rocks that may have originated from conglomerate; for we have not found as yet decided examples of pebbles in this rock. Yet so intimately connected with the conglomerate schists is the Green mountain gneiss, as the preceding details show,—so little, in fact, does it differ from the schists, that we cannot doubt but both originated from the same parent source. But the conglomerate at Wallingford affords still stronger evidence and shows us the modes in which the gneiss was produced from the conglomerate. Some of the elongated pebbles there are gneiss. But we doubt whether they were originally so; for quite often the cement is changed to gneiss. To effect this change it was only necessary that feldspar should be interpolated between the laminæ of mica or talc. And no one who has seen the specimens will imagine that it could have been introduced mechanically, by deposition, for example. The last way, or crystallization from solution, is the only other probable mode. Gneiss, perhaps, has been generally formed by such an interpolation of feldspar into the schists, and this may be the reason why we seldom, perhaps never, see pebbles in that rock. We do not yet despair, however, of finding pebbles in gneiss, now that we know how to look for them. Indeed, some varieties of it contain nodular elongated masses of feldspar interlaminated with mica which may perhaps have been originally pebbles chemically changed and elongated mechanically.

The second agency by which conglomerate has been converted into schists, is mechanical. By some force they have been flattened and elongated till they have become the quartzose laminæ of the schists. It is not probably possible for us to convey a very clear and complete idea of the evidence of this position. Would that our readers could, as we have done, visit the localities again and again and become familiar with the striking specimens there, by repeated and careful examination. From our own experience, it would not surprise us, if the conversion of the pebbles of con-

glomerates into the laminæ of schists should be pronounced preposterous by able geologists. So the idea seemed to us at first, when the facts forced it upon our attention. But as the facts compelled us to give up our scepticism, so we think it will be with any candid mind. Looking at almost any specimen of the talcose conglomerate schist, on the edge corresponding to the dip (B fig. 9,) we should see nothing but alternating laminæ of quartz and talc, or mica, and pronounce it a good example of the rock which we have called, and which is generally called, talcose schist. But a fracture at right angles reveals the flattened pebbles (A fig. 9), and shows us that their edges are what we have regarded as laminæ. Let the process of flattening be carried a little farther, and no evidence will remain that they ever were pebbles. Who knows how extensively the process may have been thus carried through in the schists and gneiss of the Green mountains, and how large a part of them may once have been conglomerate? Our aim, however, is not to show the extent of the metamorphosis, but only to prove its occurrence on a large scale.

4. A fourth conclusion forced upon us by the facts is, that the chemical constitution of the pebbles has generally been altered in the process of metamorphism without obliterating their original mechanical character.

As has been repeatedly stated, most of the pebbles in the Vermont rock are quite pure quartz, having often more or less of a vitreous aspect. In fact it is nearly pure silex; and it is that form of silex which is absolutely insoluble in anything but hydrofluoric acid; nor can we suppose the presence of any heat high enough to melt it, without completely destroying the forms of the pebbles. Yet the evidence that they have been in a plastic state so as to be molded by pressure is too decided to be resisted. How then have they been softened?

Let us recur to the conglomerate at Newport. Most of the pebbles there are not pure quartz but rather silicates of such bases as alumina, magnesia, lime and iron. Now the silicates are soluble by water containing alkalies; and such quartz as is seen in the Vermont pebbles may be the residuum of the decomposition of the silicates, the bases being abstracted to form other compounds, the quartz is left.

This may be the most probable theory of the origin of quartz rock generally. Even if we suppose it produced from sandstone, we know of no other way in which it could have been formed; for nearly all the sandstones are silicates.

But suppose the silicates in the form of pebbles to be permeated by water containing alkalies, could their bases be abstracted without entirely destroying the form of the pebbles? We do not see why this could not be done, if the mass is kept in such a state by the water that the laws of chemical affinity

should prevail, forming new compounds, and leaving the quartz behind. The chief effect upon the pebble would be to reduce its bulk, though we do find sometimes the cement so strongly adhering to the pebble, that it can hardly be separated so as to leave a smooth surface. The bases, we think, could be mostly used in forming the micaceous or talcose cement, and if there was a good deal of pressure upon the whole rock, as we may reasonably suppose, if the pebbles did shrink some, the cement would increase and the whole mass would be compacted together.

To sustain the position that the mineral constitution of pebbles in conglomerates is sometimes entirely changed without destroying their character as pebbles, we would refer to another kind of conglomerate which we have found along the eastern border of Vermont, and farther south in Massachusetts. This rock, so far as we know, has never been described in treatises on geology; but we know of four localities on the west side of Connecticut river, and its character and origin are quite obvious. We cannot here go into full details as to this rock, but shall mention only the facts that bear especially upon the point under consideration.

We define this rock as a conglomerate, with a cement of syenite, or granite, or as a syenite or granite containing pebbles, sometimes thickly and sometimes sparsely disseminated. We have found it in Whately, Mass., on Ascutney, and in Barnet, Vt. On the southeast point of Little Ascutney we find a conglomerate, or perhaps a breccia, which is made of fragments of silex and some mica, probably a sandstone with nearly pure quartz. On one side of this mass, it passes, without an intervening seam, into a porphyry, and this into granite, all forming one undivided ledge; so that the conclusion is forced upon us that the granite and porphyry have been formed out of the conglomerate. Most of the rock on Ascutney takes hornblende into its composition, and thus becomes syenite, and this abounds in black rounded masses, which are, for the most part, crystalline hornblende, with some feldspar, and which are probably pebbles transmuted. At Granby, the pebbles manifestly rounded, are either mica schist, or white almost hyaline quartz, just such as form the pebbles in the conglomerates at Wallingford and Plymouth, and the base is a fine-grained syenite, passing sometimes almost into mica schist. A pebble of hornblende schist is also sometimes seen.

In bowlders of this conglomerate found in Northampton, Mass., and probably derived from Whately, the most abundant pebbles are those of the brown sandstone, considerably metamorphosed and flattened. Those of hornblende schist are common. Sometimes they are merely crystalline hornblende, not generally laminated however, but mixed with some feldspar, and

they may become syenite, and are frequently porphyritic by distinct crystals of feldspar. The cement is syenite, often more hornblendic than usual.

When the pebbles are highly crystallized, they become so incorporated with the matrix that it is difficult to separate them with a smooth surface, and if we are not mistaken, they pass insensibly into those rounded nodules chiefly hornblendic, so common in syenite, especially that of Ascutney. We think these are produced from the metamorphoses of pebbles which have become crystalline since they were formed into conglomerate. We find them, as we think, in all stages of the metamorphosis.

These facts certainly give great plausibility to the view which supposes granite and syenite to be often the result of the metamorphosis of stratified rock. But they afford a presumption, also, in favor of the position, that pebbles, which have been plastic for ages in the rocks, may have greatly changed their mineral constitutions without essentially altering their external form. This might certainly be thoroughly done if those pebbles were permeated by water containing in solution powerful chemical agents. Some of the ingredients might thus be abstracted from the pebbles and new ones supplied, if needed to form the new compounds.

In all the cases of pebbles in unstratified rocks described above, syenite has formed the matrix. But at the meeting of the American Association at Springfield, Prof. Hubbard of Dartmouth College exhibited a specimen of pure white granite from Warren in New Hampshire, in which there lay imbedded a rounded bowlder of hornblende rock, more than a foot in diameter, and easily separable from the granite. We had no doubt but that it was mechanically rounded, nor much doubt but that its mineral character had been changed since it was enveloped in granite. Hornblende bowlders in the drift are among the most infrequent of all rocks, because hornblende schist is very limited. But in the older metamorphic conglomerates, such nodules are the most common of all, and this fact furnishes the presumption of their metamorphic origin.

The facts which we have detailed respecting the occasional presence of feldspar pebbles in the Vermont conglomerates and especially of the occasional conversion of the cement into gneiss, are most probably examples of a change of mineral character during metamorphosis. It seems hardly possible to account for a cement of crystalline mica or talc, in any other way. But when we find feldspar interpolated between the laminæ, any other than a chemical origin appears improbable. We cannot therefore but regard feldspar in perhaps all cases in the crystalline rocks, as the result of metamorphism. Silicates probably furnished the ingredients, which being abstracted by hot water,

left the excess of silica in the form of quartz, and forced the feldspar and mica to fill up the interstices. The feldspar which has converted the cement into gneiss, could have had no other origin and this fact in connection with all the rest which have been adduced, affords a presumption that feldspar in nearly all the crystalline rocks, stratified and unstratified, is a product of metamorphism.

We will add a few words as to other localities of conglomerates with flattened pebbles. The subject has opened upon us in its fullness so recently that we have not had time to visit others. But we happen to have specimens from Bernardston, Mass., in which the elongation and flattening are decided in a conglomerate micaceous schist connected with clay slate and quartz rock. The same is true to some extent in a like rock from Bellingham, Mass. Still more decided is it in bowlders of the conglomerate-syenite described above from North Hampton; as it is also in the same variety of rock on Little Ascutney. In fact we predict that this phenomenon will be found present in very many of the thoroughly metamorphic conglomerates, although not noticed by observers, because their attention was not called to it.

Less than a mile north of the conglomerate locality in Plymouth, Vt., on the east side of the pond, and nearly on the strike of the conglomerate, occurs a remarkable variety of marble in an interstratified bed several rods wide. It consists of a ground of dark limestone through which are disseminated numerous elongated masses from half an inch to six inches long, and from a quarter of an inch to an inch wide, of white, semicrystalline carbonate of lime. Their larger axes lie as nearly parallel to one another as those of the quartzose conglomerate. What their origin was I have scarcely ventured to conjecture. One naturally enquires, however, whether they may not be elongated organic remains, such as corals. At any rate, the enquiry may be worthy of consideration, whether they are not masses elongated by the same force that has acted on the not far distant conglomerate. This idea did not occur to me when in the vicinity, and therefore I did not go to determine the point. If there be any foundation for this suggestion, we should expect that the longer axes of these nodules would correspond more nearly with the dip than with the strike. I have not the slightest recollection whether it is so.

The chief interest in the facts and conclusions in this paper, lies in the light they cast upon metamorphism. We had indeed felt that there was a good deal of probability in the general doctrines of metamorphism advanced by able men. But never before have we had the various steps of the process brought directly under our eyes, and so distinctly as to confound our scepticism and challenge our belief. Instead of any prejudices in favor of the conclusions to which we have been brought, our prepossessions have been the other way. But we could not resist evidence so clear, and we find that our new views greatly illustrate the subject of metamorphism. It seems to us difficult to conceive how geologists can avoid the conclusions we have presented, if

they will visit and study the localities we have pointed out. We have indeed, specimens from them all, in the Amherst Cabinets, to the amount of several hundred pounds, and they illustrate nearly all the points we have brought out. But we advise gentlemen not to substitute an inspection of these, for the more satisfactory exhibitions in the mountains.

Amherst College, Nov. 1, 1860.

NOTE.—A brief and imperfect summary of the preceding facts and arguments having been presented by me last autumn before the Boston Natural History Society, Dr. Charles T. Jackson, who presided at the meeting, expressed his dissent from my views as to the manner in which the pebbles had been flattened and distorted, and his conviction that they had either been worn into these shapes by water, previous to aggregation, or that some of these were concretions. At a subsequent meeting, Prof. Wm. B. Rogers expressed similar views, which appeared in the published proceedings of the society.* I do not understand these distinguished geologists to have made up their minds very decidedly on the subject, especially as they have not visited the Vermont localities. But objections suggested by gentlemen of such large geological experience, deserve serious consideration.

I have already stated my objections to the theory which they adopt as to the forms of the pebbles. Prof. Rogers suggests as an objection to my views, that the pressure which I suppose to have flattened and distorted the pebbles, has not produced cleavage. But this conglomerate is not a rock in which cleavage is ever found. It is a foliated, or schistose rock. It has joints in it, such as prove very clearly that it was once in a state more or less plastic; but these (the most perfect ones especially,) cross the laminæ at nearly right angles, and could never have been produced by pressure. It is a fact, however, that some of the larger pebbles, particularly at their extremities, do show the commencement of a schistose structure, probably the result of pressure. Yet the facts do not require us to suppose the pressure on this rock to have been of the most powerful kind. In some cases indeed, as at Plymouth, the pebbles are compressed into laminæ, but in general, they are only moderately flattened, and sometimes not at all. If only moderately plastic, such effects could not have required a very enormous force.

Another objection is, that the compression has not distorted the fossil Lingulæ found in the pebbles on Taunton river, and at Newport. But I am not aware that the pebbles in the conglomerate of Taunton river, have been compressed and elongated; nor have they been, in but a part of that around Newport.

* See under GEOLOGY in this number the remarks of Prof. Rogers.

Whether they have been in the particular pebbles containing the fossils, I am unable to say.

A third objection rests upon the fact that some of the pebbles have scarcely been flattened at all, and their longer axes cross the foliation;—though I do not myself recollect to have seen any where the position was much awry. But some of them, on account of their composition, may have been scarcely at all plastic, or had such a position that the pressure affected them but slightly. We certainly ought to expect such cases.

I have been led, of late, to a reperusal of the able papers that have appeared for several years past in the English journals, on cleavage, compressed and distorted fossils, and particles of slate, by Sharpe, Sorby, Tyndall, Scrope, Scheerer, and Haughton. The result is, a conviction that the facts which I have given respecting the conglomerates, are only another phase of the phenomena described by these eminent geologists. If the facts they adduce prove the elongation and expansion of slate, limestone and fossils, as is generally conceded, although proved mainly by the microscope, why should we think it strange that the like effects may have been produced upon conglomerates, so as to show themselves on a large scale, and to unaided vision? The manner in which the veteran geologist, Scrope, supposes gneiss and mica schist may have been formed out of granite, (which he has illustrated by figures, *Phil. Magazine*, vol. li, p. 196), whatever we may think of the hypothesis, corresponds very nearly with some of my suppositions, or rather *facts*, as to the conversion of conglomerates into schists. And the ideas of most of these writers as to the former plastic condition of most of the rocks, correspond with those which I have expressed. If I am wrong, then, I have the consolation of being in good company.

Prof. Tyndall, in his recent work on the Alpine Glaciers, has referred to an interesting specimen in London, analogous to the conglomerates of Rhode Island and Vermont.

In the museum of the Government school of Mines, he says, "we have a collection of quartz stones placed there by Mr. Salter, and which have been subjected to enormous pressure, in the neighborhood of a fault. These rigid pebbles, have in some cases, been squeezed against each other so as to produce a mutual flattening and indentation. Some of them have yielded along planes passing through them, as if one half had slidden over the other; but the reattachment is very strong. Some of the larger stones, moreover, which have endured pressure at a particular point, are fissured radially around the point. In short, the whole collection is a most instructive example of the manner and extent to which some of the most rigid substances

in nature can yield on the application of a sufficient force.—(*Glaciers of the Alps*, p. 404, Amer. Ed.)

Though these specimens are not so definitely described as we could wish, we presume they are conglomerates with flattened quartz pebbles, like those in Rhode Island and Vermont. Our objections to Prof. Tyndall's hypothesis, which imputes the effect wholly to the mechanical compression of solid quartz, are as follows:

1. The compression of pure quartz pebbles, such as some of those in Rhode Island, and most of those in Vermont, would break and crush them, nor have we any reason to suppose that the fragments could be reconstructed so as to form hyaline masses, without fissures. There is no fluid, as in ice, to produce regelation; nor could the particles be brought near enough for molecular attraction, without being crushed into the finest powder, by such a pressure as the facts show not to have been exerted upon the conglomerates.

2. The compressing force has not been great enough to destroy except partially, the form of the pebbles. It has not crushed but only moulded them, except that now and then, one has been fractured. If it had been powerful enough to compress and distort solid quartz and to reunite its particles, it must have destroyed all marks of a mechanical origin in the pebbles.

3. There is evidence, as we have tried to show, in the preceding discussion, that many of the pebbles, especially in the Vermont rocks, have undergone a chemical change; that certain silicates have been abstracted from them, leaving the excess of silica in the form of quartz. This, of course, would require such a degree of plasticity, as to enable water to permeate the mass.

March 20th, 1861.

ART. XXXV.—*On some points in American Geology;* by T. STERRY HUNT, F.R.S., of the Geological Survey of Canada.

THE recent publication of two important volumes on American geology seems to afford a fitting occasion for reviewing some questions connected with the progress of geological science, and with the history of the older rock formations of North America. The first of these works is the third volume of the Palæontology of New York by James Hall; we shall not attempt the task of noticing the continuation of this author's labors in the study of organic remains, labors which have by common consent placed him at the head of American palæontologists, but we have to call attention to the introduction to this third volume, where in about a hundred pages Mr. Hall gives us a clear and admirable

summary of the principal facts in the geology of the United States and Canada, followed by some theoretical notions on the formation of mountain chains, metamorphism and volcanic phenomena, where these questions are discussed from a point of view which we conceive to be of the greatest importance for the future of geological science. A publication of this introduction in a separate form, with some additions, would we think be most acceptable to the scientific public.

The other work before us is Prof. H. D. Rogers' elaborate report on the geology of Pennsylvania, giving the results of the Survey of that State for many years carried on under his direction, and embracing a minute description of those grand exhibitions of structural geology, which have rendered that State classic ground for the student. The volumes are copiously illustrated with maps, sections and figures of organic remains, and the admirable studies on the coal fields of Pennsylvania and Great Britain add much to its value.

The oldest series of rocks known in America is that which has been investigated by the officers of the Geological Survey of Canada, and by them designated the Laurentian system. It is now several years since we suggested that these rocks are the equivalents of the oldest crystalline strata of western Scotland and Scandinavia.* This identity has since been established by Sir R. I. Murchison in his late remarkable researches in the northwestern Highlands, and he has adopted the name of the Laurentian system for these ancient rocks of Ross, Sutherland, and the Western Islands, which he at first called fundamental gneiss.† These are undoubtedly the oldest known strata of the earth's crust, and therefore offer peculiar interest to the geologist. As displayed in the Laurentide and Adirondack mountains, they exhibit a volume which has been estimated by Sir William Logan to be equal to the whole palæozoic series of North America in its greatest development. The Laurentian series consists of gneiss, generally granitoid, with great beds of quartzite, sometimes conglomerate, and three or more limestone formations, (one 1000 feet in thickness) associated with dolomites, serpentines, plumbago, and iron ores. In the upper portion of the series an extensive formation of rocks, consisting chiefly of basic feldspars without quartz and with more or less pyroxene, is met with. The peculiar characters of these latter strata, not less than the absence of argillites and talcose and chloritic schists, conjoined with various other mineralogical characteristics seem to distinguish the Laurentian series throughout its whole extent, so far as yet studied, from any other system of crystalline strata. It

* Esquisse Géologique du Canada, 1855, p. 17.
† Quar. Journal Geol. Society, vol. xv, 353; xv, 215.

appears not improbable that future researches will enable us to divide this series of rocks into two or more distinct systems.

Overlying the Laurentian series on Lake Huron and Superior, we have the Huronian system, about 10,000 feet in thickness, and consisting to a great extent of quartzites, often conglomerate, with limestones, peculiar slaty rocks, and great beds of diorite, which we are disposed to regard as altered sediments. These constitute the lower copper-bearing rocks of the lake region, and the immense beds of iron ore at Marquette and other places on the south shore of Lake Superior have lately been found by Mr. Murray to belong to this series, which is entirely wanting along the farther eastern outcrop of the Laurentian system. This Huronian series appears to be the equivalent of the Cambrian sandstones and conglomerates described by Murchison, which form mountain masses along the western coast of Scotland, where they repose in detached portions upon the Laurentian series.

Besides these systems of crystalline rocks, the latter of which is local and restricted in its distribution, we have along the great Appalachian chain, from Georgia to the Gulf of St. Lawrence, a third series of crystalline strata, which form the gneissoid and mica slate series of most American geologists, the hypozoic group of Prof. Rogers, consisting of feldspathic gneiss, with quartzites, argillites, micaceous, epidotic, chloritic, talcose and specular schists, accompanied with steatite, diorites and chromiferous ophiolites. This group of strata has been recognized by Safford in Tennessee, by Rogers in Pennsylvania, and by most of the New England geologists as forming the base of Appalachian system, while Sir William Logan, Mr. Hall, and the present writer have for many years maintained that they are really altered palæozoic sediments, and superior to the lowest fossiliferous strata of the Silurian series. Sir William Logan has shown that the gneissoid ranges in Eastern Canada have the form of synclinals, and are underlaid by shales which exhibit fossils in their prolongation, while his sections leave no doubt that these ranges of gneiss, with micaceous, chloritic, talcose and specular schists, epidosites, quartzites, diorites and ophiolites, are really the altered sediments of the Quebec group, which is a lower member of the Silurian series, corresponding to the Calciferous and Chazy formations of New York, or to the Primal and Auroral series of Pennsylvania. Prof. Rogers indeed admits that these are in some parts of Pennsylvania metamorphosed into feldspathic, micaceous and talcose rocks, which it is extremely difficult to distinguish from the hypozoic gneiss, which latter, however, he conceives to present a want of conformity with the palæozoic strata.

To this notion of the existence of two groups of crystalline rocks similar in lithological character but different in age, we

have to object that the hypozoic gneiss is identical with the Green Mountain gneiss, not only in lithological character, but in the presence of certain rare metals, such as chrome, titanium, and nickel which characterise its magnesian rocks; all of these we have shown to be present in the unaltered sediments of the Quebec group, with which Sir William Logan has identified the gneiss formation in question. Besides which the lithological and chemical characters of the Appalachian gneiss are so totally distinct from the crystalline strata of the Laurentian system, with which Prof. Rogers would seem to identify them, that no one who has studied the two can for a moment confound them. Prof. Rogers is therefore obliged to assume a new series of crystalline rocks, distinct from both the Laurentian and Huronian systems, but indistinguishable from the altered palæozoic series, or else to admit that the whole of his gneissic series in Pennsylvania is, like the corresponding rocks in Canada, of palæozoic age.* We believe that nature never repeats herself without a difference, and that certain variations in the chemical and mineralogical constitution of sediments mark successive epochs so clearly that it would be impossible to suppose the formation in adjacent regions of a series of crystalline schists like those of the Alleghanies contemporaneous with the sediments which produced the Laurentian system. We have elsewhere indicated the general principles upon which this notion of a progressive change in the composition of sediments is based, and shown how the gradual removal of alkalies from aluminous rocks has led to the formation of argillites, chloritic and epidotic rocks, at the same time removing carbonic acid from the atmosphere, while the resulting carbonate of soda by decomposing the calcareous and magnesian salts of the ocean, furnished the carbonates for the formation of limestones and dolomites, at the same time generating sea salt.†

Closely connected with these chemical questions is that of the commencement of life on the earth. The recognition beneath the Silurian and Huronian rocks, of 40,000 feet of sediments analogous to those of more recent times, carries far back into the

* Dr. Bigsby in 1824 described an extensive tract of gneissoid rocks on Rainy Lake and Lake Lacroix, north of Lake Superior. The general course of the strata he states to be "from N.W. to N. by W., with a corresponding easterly dip;" but he elsewhere speaks of the gneiss as running (dipping?) E.N.E. This gneiss often contains beds and disseminated grains of hornblende, and passes in some places into micaceous, chloritic and greenstone slates, and syenite. Staurotide is abundant in the mica schists, and octahedral iron occurs in the chloritic slates. A porphyritic granite containing beryl is also met with in this region. This gneiss is regarded by Dr. Bigsby as belonging "to transition rocks, from its constant proximity to red sandstone, the oldest organic limestone, and trap." (Am. Jour. Sci. (1), viii, 61). The lithological and mineral characters of these crystalline strata seem to be distinct from those of the Laurentian system, and to resemble those of the Appalachians. Too much praise cannot be ascribed to Dr. Bigsby for his early and extensive observations on the geognosy and mineralogy of British North America.

† This Journal [2], xxv, 102, 445, xxx, 133; and Quar. Jour. Geol. Soc., xv, 488.

past the evidence of the existence of physical and chemical conditions, similar to those of more recent periods. But these highly altered strata exclude, for the most part, organic forms, and it is only by applying to their study the same chemical principles which we now find in operation that we are led to suppose the existence of organic life during the Laurentian period. The great processes of deoxydation in nature are dependent upon organization; plants by solar force convert water and carbonic acid into hydrocarbonaceous substances, from whence bitumens, coal, anthracite and plumbago, and it is the action of organic matter which reduces sulphates, giving rise to metallic sulphurets and sulphur. In like manner it is by the action of dissolved organic matters that oxyd of iron is partially reduced and dissolved from great masses of sediments, to be subsequently accumulated in beds of iron ore. We see in the Laurentian series beds and veins of metallic sulphurets, precisely as in more recent formations, and the extensive beds of iron ore hundreds of feet thick which abound in that ancient system, correspond not only to great volumes of strata deprived of that metal, but as we may suppose, to organic matters, which but for the then great diffusion of iron oxyd in conditions favorable for their oxydation, might have formed deposits of mineral carbon far more extensive than those beds of plumbago which we actually meet in the Laurentian strata.

All these conditions lead us then to conclude to the existence of an abundant vegetation during the Laurentian period, nor are there wanting evidences of animal life in these oldest strata. Sir William Logan has described forms occurring in the Laurentian limestone which cannot be distinguished from the silicified specimens of *Stromatopora rugosa* found in the Lower Silurian rocks. They consist of concentric layers made up of crystalline grains of white pyroxene in one case and of serpentine in another, the first imbedded in limestone and the second in dolomite; we may well suppose that the result of metamorphism would be to convert silicified fossils into silicates of lime and magnesia. The nodules of phosphate of lime in some beds of the Laurentian limestones also recall the phosphatic coprolites which are frequently met with in Lower Silurian strata, and are in the latter case the exuviæ of animals which have been fed upon *Lingula*, *Orbicula*, *Conularia* and *Serpulites*, the shells and tubes of which we have long since shown to be similar in composition to the bones of vertebrates.* So far therefore from looking upon the base of the Silurian as marking the dawn of life upon our planet, we see abundant reasons for supposing that organisms, probably as varied and abundant as those of the

* Logan and Hunt, Amer. Jour. Sci. [2], xvii, 235.

palæozoic age, may have existed during the long Laurentian period.

Along the northern rim of the great palæozoic basin of North America the Potsdam sandstone of the New York geologists is unquestionably the lowest rock from below Quebec to the Island of Montreal, and thence passing up the valley of Lake Champlain and sweeping round the Adirondack mountains, until it reënters Canada and soon disappears to the north of Lake Ontario, where the Birdseye and Black River limestones repose directly upon the Laurentian rocks, and furthermore overlie the great Lake Superior group of slates and sandstones, which reposing on the unconformable Huronian system, constitute the upper copper-bearing rocks of this region. This Lake Superior group, as Sir William Logan remarks, may then include the Potsdam, Calciferous and Chazy, and thus be equivalent in part to the Quebec group hereafter to be described.

Passing westward into the Mississippi valley we again find a sandstone formation, which forms the base of the palæozoic series, and is considered by Mr. Hall to be the equivalent of the Potsdam. Here it occasionally exhibits intercalated beds of silico-argillaceous limestone, in which occur abundant remains of trilobites of the genera *Dikellocephalus*, *Menocephalus*, *Arionellus*, and *Conocephalus*. Passing upwards this sandstone is succeeded by the Lower Magnesian limestone, which is the equivalent of the Calciferous sand-rock of New York, and in Missouri, where it is the great metalliferous formation, alternates several times with a sandstone, constituting the Magnesian Limestone series, which in Missouri attains a thickness of 1300 feet. The same thing is observed to a less degree in Wisconsin and Iowa; throughout this region the higher beds of the Potsdam sandstone are often composed of rounded oolitic granules, and the beds of passage are frequently of such a character as to lead to the conclusion that they have been deposited from silica in solution, and are not mechanical sediments.* For a discussion of some facts with regard to the chemical origin of many silicious rocks, see this Journal, [2], xviii, 381.

Evidences of disturbance during the period of its deposition are to be found in the brecciated beds, sometimes fifty feet in thickness, which occur in the Calciferous sandrock of the northwest, and are made of the ruins of an earlier sandstone. In Missouri, the Birdseye and Black River limestones repose directly upon the Lower Magnesian limestone, while farther north, a sandstone intervenes, occupying the place of the Chazy limestone.

* See Mr. Hall's Introduction, to which we are indebted for many of these facts regarding the formation of the west, and also the Reports of the Geological Survey of Missouri.

The Potsdam sandstone of the St. Lawrence valley, has for the most part the character of a littoral formation, being made up in great part of pure quartzose sand, and offering upon successive beds, ripple and wind marks, and the tracks of animals. Occasionally it includes beds of conglomerate, or as at Hemmingford, encloses large rounded fragments of green and black shale; it also exhibits calcareous beds apparently marking the passage to the succeeding formation, which although called a Calciferous sandrock, is for the most part here, as in the west, a magnesian limestone, often geodiferous, and including calcite, pearl spar, gypsum, barytes and quartz. Sir William Logan had already shown that the fauna of the Potsdam and Calciferous in Canada are apparently identical, (Can. Nat., June, 1860; This Journal, [2], xxxi, 18), and Mr. Hall has arrived at the same conclusion with regard to the more extended fauna of these formations in the valley of the Mississippi, so that these two may be regarded as forming but one group. While in the west *Dikellocephalus* occurs both in the lower sandstones and the magnesian limestones, *Conocephalus minutus*, found in the Potsdam on Lake Champlain, and identified by Mr. Billings, has lately been detected by him in specimens from the sandstones of Wisconsin with *Dikellocephalus*, which genus has there been found to pass upwards into the magnesian limestones. On the other hand, the sandstones of Bastard in Canada, having the characters of the Potsdam, contain *Lingula acuminata* and *Ophileta compacta*, species regarded as characteristic of the Calciferous, together with two undescribed species of *Orthoceras*, and in another locality a *Pleurotomaria* resembling *P. Laurentina*. The researches of Mr. Billings have extended the fauna of the Calciferous in Canada to forty-one species, and the succeeding Chazy formation to 129 species. The thickness of this latter division in the St. Lawrence valley is about 250 feet, and it includes in its lower part about fifty feet of sandstones with green fucoidal shales and a bed of conglomerate. The Calciferous has a thickness of about 300 feet, while the Potsdam may be estimated at not far from 600 feet.

We have then seen that along the northeastern outcrop of the great American basin in Canada and New York, the base of the Palæozoic series is represented by less than 1000 feet of sandstones and dolomites, reposing directly upon the Laurentian system. A very different condition of things is, however, found in the more central parts of the basin. According to Prof. Rogers, the older Primal slates, which form the base of the palæozoic system, attain in Virginia a thickness of 1200 feet, and are succeeded by 300 feet of Primal sandstone marked by *Scolithus*, which he considers the Potsdam, followed by the upper Primal slates, consisting of 700 feet of greenish and brownish talco-argillaceous shales with fucoids. To these succeed his

Auroral division, consisting of sixty feet or more of calcareous sandstone, the supposed equivalent of the Calciferous sandrock, followed by the Auroral limestone, which is magnesian, and often argillaceous and cherty in the upper beds. Its thickness is estimated at from 2500 to 5500 feet, and it is supposed by Rogers to include the Chazy and Black River limestones, while the succeeding Matinal division exhibits first, from 300 to 500 feet of limestone, (Trenton), secondly, 300 to 400 feet black shale, (Utica), and thirdly, 1200 feet of shales with red slates and conglomerates, (Hudson River Group), thus completing the Lower Silurian series.

In Eastern Tennessee, Mr. Safford describes, (1st.) on the confines of North Carolina, a great volume of gneissoid and micaceous rocks similar to those of Pennsylvania, succeeded to the west by (2nd.) the Ococee conglomerates and sandstones, with argillites, chloritic, talcose and micaceous slates, and occasional bands of limestone, all dipping, like the rocks of the 1st division, to the S.E. In the 3d place we have the Chilhowee sandstones and shales, several thousand feet in thickness, including near the summit beds of sandstone with *Scolithus*, and considered by Mr. Safford the equivalent of the Potsdam. (4th.) The Magnesian limestone and shale group, also several thousand feet thick, and divided into three parts; first a series of fucoidal sandstones approaching to slates and including bands of magnesian limestone; second, a group of many hundred feet of soft brownish, greenish, and buff shales, with beds of blue oolitic limestone, which as well as the shales, contain trilobites. Passing upward these limestones become interstratified with the third sub-division, consisting of heavy bedded magnesian limestone, more or less sparry and cherty near the summit. The limestones of Knoxville belong to this group, which with the 3d or Chilhowee group is designated by Mr. Safford as Cambrian, corresponding to the Primal and Auroral of Rogers, or to the Potsdam or Calciferous sandrock, with the possible addition of the Chazy, being equivalent to the great Magnesian limestone series of Prof. Swallow of Missouri. To these strata succeed Safford's 5th formation, consisting of limestones, the equivalents of the Black River, Trenton and higher portions of the Lower Silurian.

In Eastern Canada we find a group of strata similar to those described by Rogers and Safford, and distinguished by Sir William Logan as the Quebec group. It has for its base a series of black and blue shales, often yielding roofing slates, succeeded by grey sandstones and great beds of conglomerate, with dolomites and pure limestones, often concretionary and having the character of travertines. These are associated with beds of fossiliferous limestones, and with slates containing compound graptolites, and

are followed by a great thickness of red and green shales, often magnesian, and overlaid by 2000 feet of green and red sandstone, known as the Sillery sandstone, the whole from the base of the conglomerate, having a thickness about 7000 feet. These red and green shales resemble closely those at the top of the Hudson River group, and the succeeding sandstones are so much like those of the Oneida and Medina formations, that the Quebec group was for a long time regarded as belonging to the summit of the Lower Silurian series, the more so by a great break and upthrow to the S.E., the rocks of this group are made to overlap the Hudson River formation. "Sometimes it may overlie the overturned Utica formation, and in Vermont, points of the overturned Trenton appear occasionally to emerge from beneath the overlap."* This great dislocation is traceable in a gently curving line from near Lake Champlain to Quebec, passing just north of the fortress; thence it traverses the island of Orleans, leaving a band of higher strata on the northern part of the island, and after passing under the waters of the Gulf, again appears on the main land about eighty miles from the extremity of Gaspé, where on the north side of the break, we have as in the island of Orleans, a band of Utica or Hudson River strata. To the south and east of this line the rocks of the Quebec group are arranged in long, narrow, parallel, synclinal forms, with many overturn dips. These synclinals are separated by dark gray and black shales, with limestones, hitherto regarded as of the Hudson River age, but which are perhaps the deep-sea equivalent of the Potsdam.

The presence of conglomerates and sandstones, alternating with great masses of fine shales, indicates a period of frequent disturbances, with elevations and depressions of the ocean's bottom, while the deposits of dolomite, magnesite, travertine and highly metalliferous strata show the existence of shallow water, lagoons and springs over a great area and for a long period between the formation of the upper and lower shales. We may suppose that while the Potsdam sandstone was being deposited along the shores of the great palæozoic ocean, the lower black shales were accumulating in the deeper waters, after which an elevation took place, and the magnesian strata were deposited, followed by a subsidence during the period of the upper shales and Sillery sandstones.

Associated with the magnesian strata at Point Levi and in several other localities in the same horizon of the Quebec group, an extensive fauna is found, of which 137 species are now known, embracing more than 40 new species of graptolites, which have been described by Mr. James Hall in the report of

* See Sir William Logan's letter to Barrande, Canadian Naturalist for Jan. 1861, and this volume, 261.

the Geological Survey of Canada for 1857, and thirty-six species of trilobites described by Mr. Billings in the Canadian Naturalist for August, 1860. These species are as yet distinct from anything found in the Potsdam below or the Birdseye and Black River above; although the trilobites recall by their aspect those found by Owen in the Lower Sandstone of the Mississippi. Seven species alone out of this fauna have been identified with those known in other formations, and of these one is Chazy, while six belong to the Calciferous, to which latter horizon Mr. Billings considers the Quebec group to belong. The Chazy has not yet been identified in this region, unless indeed it be represented in some of the upper portions of the Quebec group. The Calciferous sandrock is wanting along the north side of the St. Lawrence valley from near Lake St. Peter to the Mingan Islands, but at Lorette behind Quebec, at the foot of the Laurentides, the Birdseye limestone is found reposing conformably upon the Potsdam sandstone.

It is not easy to find the exact horizon of the Potsdam sandstone among the black shales which underlie the Quebec group. The *Scolithus* of Rogers' Primal sandstone, and of the summit of Safford's 3d or Chilhowee formation is identical with that found in the quartz rock at the western base of the Green mountains, and figured by Mr. Hall in the 1st volume of the Palæontology. It is however distinct from what has been called *Scolithus* in the Potsdam of Canada. The value of this fossil as a means of identification is diminished by the fact that similar marks are found in sandstones of very different ages. Thus a *Scolithus* very like that of the St. Lawrence valley occurs in the sandstone of Lake Superior and in the Medina sandstone, while in Western Scotland, according to Mr. Salter, the two quartzite formations above and below the Lower Silurian limestones of Chazy age are alike characterized by these tubular markings, which are regarded by him as produced by annelids or sea-worms. We find however in shales which underlie the Quebec group at Georgia in Vermont, trilobites which were described by Mr. Hall in 1859 as belonging to the genus *Olenus*, a recognized primordial type; he has since erected them into a new genus. Again at Braintree in Eastern Massachusetts occur the well known *Paradoxyds* in an argillaceous slate. These latter fossils Mr. Hall suggests probably belong to the same horizon as certain slaty beds in the Potsdam sandstone, or perhaps even at the base of this formation. (Introduction, page 9.) In this connection we must recall the similar shales of Newfoundland, in which Salter has recognized trilobites of the same genus. These shales containing *Paradoxyds*, like those underlying the Quebec group, thus appear to belong to the Primordial zone, and are to be regarded as the equivalents of the Potsdam sandstone

which both in Lake Champlain and in the Mississippi valley is characterized by primordial types. The intermingling of Potsdam and Calciferous forms to which we have already alluded, seems however to show that it will be difficult to draw any well defined zoological horizon between the different portions of these lower rocks, which at the same time offer as yet no evidence of any fauna lower than that of the Potsdam. So that we regard the whole Quebec group with its underlying Primordial shales as the greatly developed representative of the Potsdam and Calciferous (with perhaps the Chazy), and the true base of the Silurian system.

The Quebec group with its underlying shales is no other than the Taconic system of Emmons. Distinct in its lithological characters from the Potsdam and Calciferous formations as developed on Lake Champlain, Mr. Emmons was led to regard these strata as belonging to a lower or sub-Silurian group. We have however shown that the palæontological evidence afforded by this formation gives no support to such a view. To Mr. Emmons is however undoubtedly due the merit of having for a long time maintained that the Taconic hills are composed of strata inferior to the Trenton limestones, brought up into their present position by a great dislocation, with an upthrow on the eastern side. We would not object to the term Taconic if used as indicating a subdivision of the Lower Silurian series, but as the name of a distinct and sub-Silurian system it can no longer be maintained. The Quebec group evidently increases in thickness as we proceed toward the south, and the calcareous parts of the formation are more developed. In 1859, I visited in company with Mr. A. D. Hager the marble quarries of Rutland and Dorset, in Vermont. The latter occur in a remarkable synclinal mountain of nearly horizontal strata of marble and dolomite, capped by shales, and attaining a height of 2700 feet above the railway station at its base. I then identified these marbles with the limestones of the Quebec group, considering them to be beds of chemically precipitated carbonate of lime or travertine, and not limestones of organic origin.

The existence of great dislocations in the Appalachian chain is amply illustrated in the sections of Prof. Rogers, and in those given by Safford in Eastern Tennessee, where by the aid of fossils it becomes comparatively easy to trace them. See the Map accompanying his *Geographical Reconnaisance of Tennessee*, 1855; where the magnesian limestones of formation IV, are shown to be not only brought up on the east against the Upper Silurian and Devonian, but even to overlap the black shales at the base of the Carboniferous system. It is remarkable to find that as early as 1822, the idea of a great dislocation of this nature in Eastern New York was maintained by Mr. D. H. Barnes in his description of Canaan mountain. (This Journal, [1], v, pp. 15–18).

To the southeast of this great fault in Canada we have as yet no evidence of Lower Silurian strata higher than those of the Quebec group. At the eastern base of the Green mountains, we find limestones of upper Silurian and Devonian age reposing unconformably upon the altered strata of the Quebec group, themselves also having undergone more or less alteration. Immediately succeeding are the chiastolite and mica slates of Lake St. Francis, which as we have long since stated are probably also of Upper Silurian age.

The White mountains as we suggested in 1849, (this Journal, [2], ix, 19), are probably, in part at least, of Devonian age, and are the representatives of 7000 feet of Devonian sandstone observed by Sir William Logan in Gaspé. Mr. J. P. Lesley has more recently, after an examination of the White mountains, shown that they possess a synclinal structure, and has adduced many reasons for regarding them as of Devonian age. (Amer. Mining Journal, Jan. 1861, p. 99).

It will be seen from what has been previously said that we look upon the 1st and 2d divisions described by Mr. Safford in Eastern Tennessee, as corresponding to the hypozoic series of Rogers and to the Green mountain gneissic formation, which instead of being beneath the Silurian series, is really a portion of the Quebec group more or less metamorphosed, so that we recognize nothing in New England or southeastern Canada lower than the Silurian system, nor do we at present see any evidence of older strata, such as Laurentian or Huronian, in any part of the Appalachian chain. The general conclusions which we have previously expressed with regard to the lithological, chemical and mineral relations of the Green mountain rocks remain unchanged. (This Journal [2], ix, 12).

The remarkable parallelism between the rocks of Western Scotland and Canada has already been shown in the existence of the Laurentian, and Cambrian (Huronian) systems, overlaid by quartzites containing *Scolithus,* to which succeed limestones containing a numerous fauna, identified by Mr. Salter with that of the Chazy limestone. These strata, with an eastward dip, are covered by other quartzites and limestones, to which succeeds the great gneissoid formation of the western Highlands, consisting of feldspathic, chloritic, micaceous, and talcose schists resembling closely the gneissoid rocks of the Green mountains, and including the chromiferous ophiolites of Perthshire, Banff and the Shetland Isles.

This gneissoid series was by Prof. Nicol suggested to be the older or Laurentian gneiss brought up by a dislocation on the east of the Silurian limestones, but Sir Roderick Murchison, with Messrs. Ramsay and Harkness, has shown not only from the differences in lithological character, but from actual sections, that the eastern

gneissoid series is made up of altered strata newer than the Silurian limestones.* Thus in geological structure and age, not less than in lithological and mineralogical characters, the rocks of the western Highlands are the counterparts of the Laurentian and Silurian gneiss formations, as seen in the Laurentides and Adirondacks, and in the Green mountains. The same parallelism may be extended by Scandinavia, (where Kjerulf and Forbes have shown much of the crystalline gneiss to be of Silurian age,) marking as it would seem the outer edge of a vast Silurian basin, which may be followed in the other direction across the Atlantic to the Gulf of Mexico. We also remark in Great Britain as in America, that whereas the northern outcrop of the palæozoic basin offers at its base only a series of quartzose sandstones reposing upon the Laurentian system and characterized by fucoids and *Scolithus*, we find further south in England an immense development of shales, sandstones and conglomerates, which form the base of the Silurian system and correspond to the Primordial zone and the Quebec group.

We have said that upon Lake Huron and Superior the sandstones of the upper copper-bearing rocks are the equivalents of the Quebec group. The clear exposition of the question by Mr. J. D. Whitney in the Mining Journal for 1860 (p. 435) left little more to be said, but the sections made last year by Mr. Alex. Murray of the Canadian Geological Survey place the matter beyond all doubt. On Campment d'Ours, a small island near St. Joseph's, the sandstones of Sault St. Mary are seen reposing horizontally upon the upturned edges of the Huronian rocks, and overlaid by limestones which contain in abundance the fossils of the Black River and Birdseye divisions. The only fossil as yet found in these sandstones is a single *Lingula* from near Sault St. Mary, which may be either of Potsdam or Chazy age. The sandstones in question form the upper member of a series of strata which on Lake Superior attain a thickness of several thousand feet, and passing downwards we find a succession of limestones, marls and argillaceous sandstones, interstratified with greenstone and amygdaloid, and followed by about 2000 feet of bluish slates and sandstones, with cherty beds containing grains of anthracite, the whole underlaid by conglomerates, and reposing unconformably upon rocks of the Huronian system. The presence of such slates is the more significant from the occurrence already mentioned of fragments of green and black slates in the coarse grained sandstones near the base of the Potsdam, at Hemmingford mountain, showing the existence of argillaceous shales before the deposition of the quartzites of the Potsdam; these are more recent than the lowest shales of the

* Murchison, Quar. Jour. Geol. Society, vol. xv, 353 and xvi, 215.

Primordial zone, to which, however, palæontologically they appear to belong.

This Quebec group is of considerable economic interest inasmuch as it is the great metalliferous formation of North America. To it belongs the gold which is found along the Appalachian chain from Canada to Georgia, together with lead, zinc, copper, silver, cobalt, nickel, chrome and titanium. I have long since called attention to the constant association of the latter metals, particularly chrome and nickel, with the ophiolites and magnesian rocks of this series, while they are wanting in similar rocks of Laurentian age. (This Journal, [2], xxvi. 237).

The immense deposits of copper ores in Eastern Tennessee, and the similar ones in Lower Canada, both of which are for the most part in beds subordinate to the stratification, belong to this group. The lead, copper, zinc, cobalt and nickel of Missouri, and the copper of Lake Superior, also occur in rocks of the same age, which appears to have been preëminently the metalliferous period.

The metals of the Quebec group seem to have been originally brought to the surface in watery solution, from which we conceive them to have been separated by the reducing agency of organic matter in the form of sulphurets, or in the native state, and mingled with the contemporaneous sediments, where they occur in beds, in disseminated grains forming *fahlbands*, or as at Acton, are the cementing material of conglomerates. During the subsequent metamorphism of the strata these metallic matters being taken into solution by alkaline carbonates or sulphurets, have been redeposited in fissures in the metalliferous strata, forming veins, or ascending to higher beds, have given rise to metalliferous veins in strata not themselves metalliferous. Such we conceive to be in a few words the theory of metallic deposits; they belong to a period when the primal sediments were yet impregnated with metallic compounds which were soluble in the permeating waters. The metals of the sedimentary rocks are now however for the greater part in the form of insoluble sulphurets, so that we have only traces of them in a few mineral springs, which serve to show the agencies once at work in the sediments and waters of the earth's crust. The present occurrence of these metals in waters which are alkaline from the presence of carbonate of soda, is as we have elsewhere pointed out, of great significance when taken in connection with the metalliferous character of certain dolomites, which as we have shown probably owe their origin to the action of similar alkaline springs upon basins of sea water.

The intervention of intense heat, sublimation and similar hypotheses to explain the origin of metallic ores, we conceive to be uncalled for. The solvent powers of solutions of alkaline car-

bonates, chlorids and sulphurets at elevated temperatures, taken in connection with the notions above enunciated, and with De Senarmont's and Daubrée's beautiful experiments on the crystallization of certain mineral species in the moist way, will suffice to form the basis of a satisfactory theory of metallic deposits.*

The sediments of the carboniferous period, like those of earlier formations, exhibit towards the east a great amount of coarse sediments, evidently derived from a wasting continent, and are nearly destitute of calcareous beds. In Nova Scotia Sir William Logan found by careful measurement, 14,000 feet of carboniferous strata; and Professor Rogers gives their thickness in Pennsylvania as 8000 feet, including at the base 1400 feet of conglomerate, which disappears before reaching the Mississippi. In Missouri Prof. Swallow finds but 640 feet of carboniferous strata, and in Iowa their thickness is still less, the sediments composing them being at the same time of finer materials. In fact, as Mr. Hall remarks, throughout the whole palæozoic period we observe a greater accumulation and a coarser character of sediments along the line of the Appalachian chain, with a gradual thinning westward, and a deposition of finer and farther transported matter in that direction. To the west, as this shore-derived material diminishes in volume, the amount of calcareous matter rapidly augments. Mr. Hall concludes therefore that the coal-measure sediments were driven westward into an ocean, where there already existed a marine fauna. At length, the marine limestones predominating, the coal measures come to be of little importance, and we have a great limestone formation of marine origin, which in the Rocky Mountains and New Mexico occupies the horizon of the coal, and itself unaltered, rests on crystalline strata like those of the Appalachian range. In truth, Mr. Hall observes, the carboniferous limestone is one of the most extensive marine formations of the continent, and is characterized over a much greater area by its marine fauna than by its terrestrial vegetation.

"The accumulations of the coal period were the last that gave form and contour to the eastern side of our continent, from the Gulf of St. Lawrence to the Gulf of Mexico; and as we have shown that the great sedimentary deposits of successive periods have followed essentially the same course, parallel to the mountain ranges, we naturally inquire: What influence this accumulation has had upon the topography of our country, and whether the present line of mountain elevation from northeast and southwest is in any way connected with the original accumulation of sediments?" *Hall's Introduction*, p. 66.

The total thickness of the palæozoic strata along the Appalachian chain is about 40,000 feet, while the same formations in

* Quar. Jour. Geol. Soc., vol. xv, 580.

the Mississippi valley, including the carboniferous limestone, which is wanting in the east, have, according to Mr. Hall, a thickness of scarce 4000 feet.* In many places in this valley we find the Silurian formations exposed, exhibiting hills of 1000 feet, made of horizontal strata, with the Potsdam sandstone for their base, and capped by the Niagara limestone, while the same strata in the Appalachians would give them ten to sixteen times that thickness. Still, as Mr. Hall remarks, we have there no mountains of corresponding altitude, that is to say, none whose height, like those of the Mississippi valley, equals the actual vertical thickness of the strata comprising them. In the west there has been little or no disturbance, and the highest elevations mark essentially the aggregate thickness of the strata comprising them. In the disturbed regions of the east on the contrary, though we can prove that certain formations of known thickness are included in the mountains, the height of these is never equal to the aggregate amount of the formations. "We thus find that in a country not mountainous, the elevations correspond to the thickness of the strata, while in a mountainous country, where the strata are immensely thicker, the mountain heights bear no comparative proportion to the thickness of the strata." "While the horizontal strata give their whole elevation to the highest parts of the plain, we find the same beds folded and contorted in the mountain region, and giving to the mountain elevations not one-sixth of their actual measurement."

Both in the east and west, the valleys exhibit the lower strata of the palæozoic series, and it is evident that had the eastern region been elevated without folding of the strata, so as to make the base of the series correspond nearly with the sea level, as in the Mississippi valley, the mountains exposed between these valleys, and including the whole palæozoic series, would have a height of 40,000 feet; so that the mountains evidently correspond to depressions of the surface, which have carried down the bottom rocks below the level at which we meet them in the valleys. In other words the synclinal structure of these mountains depends upon an actual subsidence of the strata along certain lines.

We have been taught to believe that mountains are produced by upheaval, folding and plication of the strata, and that from some unexplained cause these lines of elevation extend along

* In Michigan according to the late report of Prof. Winchell the total observed thickness of the strata from the top of the Sault St. Mary sandstones to the top of the carboniferous series is little over 1790 feet, divided as follows:—Trenton and Hudson River groups, 50 feet, Upper Silurian 185, Devonian 782, Carboniferous 700; of this last the true coal measures constitute 123 feet, including from 3 to 10 feet of workable bituminous and cannel coals, while near the base of the carboniferous series are found 169 feet of gypsiferous marls, which yield strong brine springs.

certain directions, gradually dying out on either side, and subsiding at the extremities. We have, however, here shown that the line of the Appalachian chain is the line of the greatest accumulation of sediments, and this great mountain barrier is due to original deposition of materials, and not to any subsequent forces breaking up or disturbing the strata of which it is composed."

We have given Mr. Hall's reasoning on this subject, for the most part in his own words, and with some detail, for we conceive that the views which he is here urging are of the highest importance to a correct understanding of the theory of mountains. In the last volume of this Journal ([2], xxx, 137,) will be found an allusion to the rival theories of upheaval and accumulation as applied to volcanic mountains, the discussion between which we conceive to be settled in favor of the latter theory by the reasonings and observations of Constant-Prevost, Scrope and Lyell. A similar view applied to mountain chains like those of the Alps, Pyrennees and Alleghanies, which are made up of aqueous sediments, has been imposed upon the world by the authority of Humboldt, Von Buch and Elie de Beaumont, with scarcely a protest. Buffon, it is true, when he explained the formations of continents by the slow accumulation of detritus beneath the ocean, conceived that the irregular action of the water would give rise to great banks or ridges of sediments, which when raised above the waves must assume the form of mountains, and later, in 1832, we find De Montlosier protesting against the elevation hypothesis of Von Buch, and maintaining that the great mountain chains of Europe are but the remnants of continental elevations which have been cut away by denudation, and that the foldings and inversions to be met with in the structure of mountains are to be looked upon only as local and accidental.

In 1856, Mr. J. P. Lesley published a little volume entitled *Coal and its Topography*, (12mo, pp. 224), in the second part of which he has in a few brilliant and profound chapters discussed the principles of topographical science with the pen of a master. Here he tells us that the mountain lies at the base of all topographical geology. Continents are but congeries of mountains, or rather the latter are but fragments of continents, separated by valleys which represent the absence or removal of mountain land (p. 126); and again "mountains terminate where the rocks thin out." (p. 144.)

The arrangement of the sedimentary strata of which mountains are composed may be either horizontal, synclinal, anticlinal or vertical, but from the greater action of diluvial forces upon anticlinals in disturbed strata it results that great mountain

chains are generally synclinal in their structure, being in fact but fragments of the upper portion of the earth's crust, lying in synclinals, and thus preserved from the destruction and translation which has exposed the lower strata in the anticlinal valleys, leaving the intermediate mountains capped with lower strata. The effects of those great and mysterious denuding forces which have so powerfully modified the surface of the globe become less apparent as we approach the equatorial regions, and accordingly we find that in the southern portion of the Appalachian chain many of the anticlinal folds have escaped erosion, and appear as hills of an anticlinal structure. The same thing is occasionally met with further north; thus Sutton mountain in Canada, lying between two anticlinal valleys, has an anticlinal centre, with two synclinals on its opposite slopes. Its form appears to result from three anticlinals, the middle of which has to a great extent escaped denudation.

The error of the prevailing ideas upon the nature of mountain chains may be traced to the notion that the disturbed condition of the strata was not only essential to the structure of a mountain, but an evidence of its having been formed by local upheaval, and the great merit of De Montlosier and Lesley, (the latter altogether independently,) is to have seen that the upheaval has been in all cases not local but continental, and that the disturbance so often seen in the strata is neither dependent upon elevation nor essential to the formation of a mountain. The synclinal structure of portions of the Alps, previously observed by Studer and others, has been beautifully illustrated by Ruskin in the fourth volume of his *Modern Painters*, and in a late review of Alpine geology we have endeavored to show that the Alps, *as a whole*, have likewise a synclinal structure. (Amer. Jour. Science, xxix, 118.)

Such was the state of the question when Mr. Hall came forward, bringing his great knowledge of the sedimentary formations of North America to bear upon the theory of continents and mountains. These were first advanced in his address delivered before the American Association for the Advancement of Science, as its president, at Montreal in August, 1857. This address was never published, but the author's views were brought forward in the first volume of his *Report on the Geology of Iowa*, p. 41, and with more detail in the introduction to the third volume of his *Palæontology of New York*, from which we have taken the abstract already given. He has shown that the difference between the geographical features of the eastern and central parts of North America is directly connected with the greater accumulation of sediment along the Appalachians. He has further shown that so far from local elevation being concerned in the formation of these mountains, the strata which

form their base are to be found beneath their foundations at a much lower horizon than in the undisturbed hills of the Mississippi valley, and that to this depression, chiefly, is due the fact that the mountains of the Appalachian range do not, like those hills, exhibit in their vertical height above the sea the whole accumulated thickness of the palæozoic strata which lie buried beneath their summits.

Mr. Hall has made a beautiful application of these views to explain the fact of the height of the Green mountains over the Laurentides, and of the White mountains over the former, by remarking that we have successively the Lower and Upper Silurian strata superimposed on those of the Laurentian system. The same thing is strikingly shown in the fact that the higher mountain chains of the globe are composed of newer formations, and that the summits of the Alps are probably altered sediments of tertiary age. (This Journal, xxix, 118.)

The lines of mountain elevation of De Beaumont are according to Hall, simply those of original accumulations, which took place along current or shore lines, and have subsequently, by continental elevations, produced mountain chains. They were not then due to a later action upon the earth's crust, "but the course of the chain and the source of the materials were predetermined by forces in operation long anterior to the existence of the mountains or of the continent of which they form a part." p. 86.

It will be seen from what we have said of Buffon, De Montlosier and Lesley that many of the views of Mr. Hall are not new but old; it was, however, reserved to him to complete the theory and give to the world a rational system of orographic geology. He modestly says, "I believe I have controverted no established fact or principle beyond that of denying an influence of local elevating forces, and the intrusion of ancient or plutonic formations beneath the lines of mountains, as ordinarily understood and advocated. In this I believe I am only going back to the views which were long since entertained by geologists relative to continental elevations." p. 82.

The nature of the palæozoic sediments of North America clearly show that they were accumulated during a slow progressive subsidence of the ocean's bed, lasting through the palæozoic period, and this subsidence which would be greatest along the line of greatest accumulation, was doubtless, as Mr. Hall considers, connected with the transfer of sediment and the variations of local pressure acting upon the yielding crust of the earth, agreeably to the view of Sir John Herschel. The subsidence of the ocean's bottom would, according to Mr. Hall, cause plications in the soft and yielding strata. Lyell had already in speculating upon the results of a cooling and contracting sea of

molten matter, such as he imagined might have once underlaid the Appalachians, suggested that the incumbent flexible strata, collapsing in obedience to gravity would be forced, if this contraction took place along narrow and parallel zones of country, to fold into a smaller space as they conformed to the circumference of a smaller arc, "thus enabling the force of gravity, though originally exerted vertically, to bend and squeeze the rocks as if they had been subjected to lateral pressure.*

Admitting thus Herschel's theory of subsidence and Lyell's of plication, Mr. Hall proceeds to inquire into the great system of foldings presented by the Appalachians. The sinking along the line of greatest accumulation produces a vast synclinal, which is that of the mountain ranges, and the result of such a sinking of flexible beds will be the production within the greater synclinal of numerous smaller synclinal and anticlinal axes, which must gradually decline toward the margin of the great synclinal axis. This process the author observes appears to furnish a satisfactory explanation of the difference of slope on the two sides of the Appalachian anticlinals, where the dips on one side are uniformly steeper than on the other. p. 71.

An important question here arises, which is this;—while admitting with Lyell and Hall that parallel foldings may be the result of the subsidence which accompanied the deposition of the Appalachian sediments, we inquire whether the cause is adequate to produce these vast and repeated flexures, presented by the Alleghanies. Mr. Billings in a recent paper in the *Canadian Naturalist* (Jan. 1860), has endeavored to show that the foldings thus produced must be insignificant when compared with the great undulations of strata, whose origin Prof. Rogers has endeavored to explain by his theory of earthquake waves propagated through the igneous fluid mass of the globe, and rolling up the flexible crust. We shall not stop to discuss this theory, but call attention to another agency hitherto overlooked, which must also cause contraction and folding of the strata, and to which we have already alluded (Am. Jour. Sci. [2], xxx, 138). It is the condensation which must take place when porous sediments are converted into crystalline rocks like gneiss and mica slate, and still more when the elements of these sediments are changed into minerals of high specific gravity, such as pyroxene, garnet, epidote, staurotide, chaistolite and chloritoid. This contraction can only take place when the sediments have become deeply buried and are undergoing metamorphism, and is, as many attendant phenomena indicate, connected with a softened and yielding condition of the lower strata.

We have now in this connection to consider the hypothesis which ascribes the corrugation of portions of the earth's crust to

* Travels in N. America, 1st visit, vol. i, p. 78.

the gradual contraction of the interior. An able discussion of this view will be found in the American Journal of Science [2] iii, 176, from the pen of Mr. J. D. Dana, who, in common with all others who have hitherto written on the subject, adopts the notion of the igneous fluidity of the earth's interior.

We have however elsewhere given our reasons for accepting the conclusion of Hopkins and Hennessy that the earth, instead of being a liquid mass covered with a thin crust, is essentially solid to a great depth, if not indeed to the centre, so that the volcanic and igneous phenomena generally ascribed to a fluid nucleus have their seat as Keferstein and after him Sir John Herschel long since suggested, not in the anhydrous solid unstratified nucleus, but in the deeply buried layers of aqueous sediments which, permeated with water, and raised to a high temperature, become reduced to a state of more or less complete igneo-aqueous fusion. So that beneath the outer crust of sediments, and surrounding the solid nucleus we may suppose a zone of plastic sedimentary material, adequate to explain all the phenomena hitherto ascribed to a fluid nucleus. (Quar. Jour. Geol. Society, Nov. 1859. Canadian Naturalist, Dec. 1859, and Amer. Jour. Sci. [2,] xxx, 136).

This hypothesis, as we have endeavored to show, is not only completely conformable with what we know of the behavior of aqueous sediments impregnated with water and exposed to a high temperature, but offers a ready explanation of all of the phenomena of volcanos and igneous rocks, while avoiding the many difficulties which beset the hypothesis of a nucleus in a state of igneous fluidity. At the same time any changes in volume resulting from the contraction of the nucleus would affect the outer crust through the medium of the more or less plastic zone of sediments, precisely as if the whole interior of the globe were in a liquid state.

The accumulation of a great thickness of sediment along a given line would by destroying the equilibrium of pressure cause the somewhat flexible crust to subside; the lower strata becoming altered by the ascending heat of the nucleus would crystallize and contract, and plications would thus be determined parallel to the line of deposition. These foldings, not less than the softening of the bottom strata, establish lines of weakness or of least resistance in the earth's crust, and thus determine the contraction which results from the cooling of the globe to exhibit itself in those regions and along those lines where the ocean's bed is subsiding beneath the accumulating sediments. Hence we conceive that the subsidence invoked by Mr. Hall, although not the sole nor even the principle cause of the corrugations of the strata, is the one which determines their position and direction, by making the effects produced by the contraction, not only

of sediments, but of the earth's nucleus itself, to be exerted along the lines of greatest accumulation.

It will readily be seen that the lateral pressure which is brought to bear upon the strata of an elongated basin by the contraction of the globe, would cause the folds on either side to incline to the margin of the basin, and hence we find along the Appalachians, which occupy the western side of such a great synclinal, the steeper slopes, the overturn dips or folded flexures, and the overlaps from dislocation are to the westward, so that the general dip of the strata is to the centre of the basin, on the other side of which we might expect to find the reverse order of dips prevailing. The apparent exceptions to this order of upthrows to the southeast in the Appalachians appear to be due to small downthrows to the southeast, parallel to and immediately to the northwest of great upheavals in the same direction.

Mr. Hall adopts the theory of metamorphism which we have expounded in the pages of this Journal and in the paper just quoted above, (see also Am. Jour. Sci. [2,] xxv, 287, 435, xxx, 135), which has received a strong confirmation from the late researches of Daubrée. According to this view, which is essentially that put forward by Herschel and Babbage, these changes have been effected in deeply buried sediments by chemical reactions, which we have endeavored to explain, so that metamorphism, like folding, takes place along the lines of great accumulation. The appearance at the surface of the altered strata is the evidence of a considerable denudation. It is probable that the gneissic rocks of Lower Silurian age in North America were at the time of their crystallization overlaid by the whole of the palæozoic strata, while the metamorphism of carboniferous strata in eastern New England points to the former existence of great deposits of newer and overlying deposits, which were subsequently swept away.

On the subject of igneous rocks and volcanic phenomena, Mr. Hall insists upon the principles which we were, so far as we know, the first to point out, namely their connection with great accumulations of sediment, and of active volcanos with the newer deposits. We have elsewhere said: "the volcanic phenomena of the present day appear, so far as we are aware, to be confined to regions of newer secondary and tertiary deposits, which we may suppose the central heat to be still penetrating, (as shown by Mr. Babbage), a process which has long since ceased in the palæozoic regions." To the accumulation of sediments then we referred both modern volcanos and ancient plutonic rocks; these latter, like lavas, we regard in all cases as but altered and displaced sediments, for which reason we have called them exotic rocks. (Am. Jour. Sci. [2,] xxx, 133). Mr. Hall reiterates these

views, and calls attention moreover to the fact that the greatest outbursts of igneous rock in the various formations appear to be in all cases connected with rapid accumulation over limited areas, causing perhaps disruptions of the crust, through which the semi-fluid stratum may have risen to the surface. He cites in this connection the traps with the palæozoic sandstones of Lake Superior, and with the mesozoic sandstones of Nova Scotia and the Connecticut and Hudson valleys.

It may sometimes happen that the displaced and liquified substratum will find vent, not along the line of greatest accumulation, but along the outskirts of the basin. Thus in eastern Canada it is not along the chain of the Notre Dame mountains, but on the northwest side of it that we meet with the great outbursts of trachyte and dolerite, whose composition and distribution we have elsewhere described. (Report of Geological Survey for 1858, and Am. Jour. Science, [2,] xxix, 285).

The North American continent, from the grand simplicity of its geological structure, and from the absence, over great areas, of the more recent formations, offers peculiar facilities for the solution of some of the great problems of geology; and we cannot finish this article without congratulating ourselves upon the great progress in this direction which has been made within the last few years by the labors of American geologists.

Montreal, March 1st, 1861.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

Physics.

1. *On Regelation.*—In the year 1850, Prof. Faraday directed the attention of scientists to the remarkable fact that two pieces of moist ice when placed in contact will unite, even when the surrounding temperature is above 0° C. To the phenomenon in question the term "regelation," has been applied by Tyndall, who has made the fact above mentioned the basis of a theory of the plasticity of ice, in accounting for the descent of glaciers. Several theories have been advanced to explain the facts of regelation. Faraday* explained it by assuming that a particle of water can retain its fluid condition only when in contact with ice on one side, but freezes when touched by ice on both sides, the general temperature remaining the same. This explanation—with all deference be it said—is simply a re-statement of the fact and not an assignment of a physical cause. Person maintains that the solution of ice is a *gradual* process, the ice passing through intermediate states of viscosity to the condition of a liquid. He considers ice as essentially colder than the water in contact with it; that a film of plastic ice or viscid water lies between the ice and the water, and that heat is constantly passing from the water to

* Researches in Chemistry and Physics, pp. 373, 378.

the ice through this film. The water therefore becomes colder and finally freezes. This view is adopted by Prof. J. D. Forbes.* Neither Person nor Forbes explain why a thin film of water in contact with a mass of ice has or can have any other temperature than the ice itself, nor why water at 0° should give off heat to ice at 0°. Prof. James Thomson's theory† is in his own words as follows: If to a mass of ice at its melting point, pressures tending to change its form be applied, there will be a continual succession of pressures applied to particular parts—liquefaction occurring in these parts through the lowering of the melting-points by pressure—evolution of the cold (*sic*) by which the so melted portions had been held in the frozen state—dispersion of the water so produced in such directions as will afford relief to the pressure—and recongelation by the cold previously evolved, of the water on its being relieved from this pressure: the cycle of operations will then begin again; for the parts re-congealed, after having been melted, must in their turn, through the yielding of other parts, receive pressures from the applied forces, thereby to be again liquefied and to proceed through successive operations as before. This theory certainly appears to be tenable in the case of glaciers, or wherever great pressures are applied, as in the moulding of ice under a hydrostatic press, but its application is to say the least, doubtful in the case of simple contact between small masses of ice. Moreover Faraday has shown that pressure is not necessary in regelation. Of the numerous experiments which he has instituted the following appears to us the most convincing. Two round cakes of ice, convex upon the upper surfaces, are placed in water of ordinary temperature and then sunk beneath the surface by little weights of wax or spermaceti. Two such pieces of ice touching each other gently at a single point freeze together. In this case no sensible capillary action takes place in consequence of the figures of the masses of ice. Faraday did not succeed in obtaining regelation with melted bismuth, tin and lead, nor with glacial acetic acid, or saline bodies. He considers the phenomenon therefore as peculiar to water. W. G.

2. *On the changes produced in the position of the fixed lines in the spectrum of hyponitric acid by changes in density.*—Weiss has found by actual measurement that the distance between the dark lines in the spectrum of hyponitric acid diminishes as the density of the gas increases. The measurements were made with an Oertling's circle reading directly to two seconds of arc and, by a filar micrometer in the ocular, to a single second. The same phenomenon occurs with the spectrum of chlorophyll. The stronger the extract in ether the less is the distance of the absorption bands. Thus the absorption-band in the red in the case of a strong extract corresponds quite well with Fraunhofer's line C; in the case of a weak extract it stands at some distance from it. The other absorption-bands in this spectrum undergo similar dislocations.

These changes in the distances of the dark lines are very sensible even in the spectrum of hyponitric acid, when the changes in the density of the gas are considerable; they are not however equal for all the dark lines.

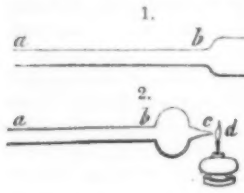
* Proceedings of the Royal Society of Edinburgh, April 19th, 1858.

† Royal Society Proceedings, vol. x, p. 152.

The cause of these dislocations is to be sought, according to Weiss, in a one-sided absorption which each line undergoes toward the violet end of the spectrum, when the density of the body is increased. This is shown by direct observations and comparisons with the solar spectrum as well as by numerous measurements. There is no specific absorption upon both sides of each line, but only an absorption upon the side of the line which lies toward the violet end of the spectrum. In this manner the bands become broader and the distance between them less. The author has observed similar changes in the breadth of Fraunhofer's lines at sunset. In this case also the absorption was only upon one side. From this it appears that the lines of hyponitric acid cannot be used as standards in determinations of indices, &c.—*Pogg. Ann.*, cxii, p. 153, Jan. 1861. W. G.

3. *Note on Dr. J. LeConte's Paper (on the influence of Musical Sounds on the flame of a jet of Coal Gas,* [This Jour. [2], xxv, 62]), *with an experiment by Dr. Charles Sondhauss,* Director of the Realschule of Neisse, (in a letter to Dr. William Sharswood).—"The observation of your friend Dr. LeConte is very interesting, although I must beg leave to differ from his theory of "molecular cohesion," or attraction between the particles of an aeriform body, particularly at the high temperature of flame. Such an hypothesis, however, seems to me unnecessary as an explanation of the phenomenon; nor does this theory demonstrate that the gas-flame is a body different from air:—in which case the flame would be removed from the external tendency to oscillation, and by its own oscillation would even bring the surrounding air or gas column into a state of fluctuation and singing, as in the case of the chemical harmonicon.

Thus a flame operates to surround and hold together the gas column as a separate body. This becomes quite evident from the following experiment which I have devised.



I employ a glass tube of the following form, fig. 1, or fig. 2, which is open at both ends. Half of the opening (*c*), is placed close to a small flame of an alcohol lamp, (*d*): with the mouth fixed at (*a*), I blow a slow current of air, when there is produced a loud whistling tone, the pitch of which is governed by the dimensions of the apparatus, as well as by the force with which the current of air is produced. The dimensions of the glass tube used by me, are, 150–240 centimetres long, the opening at (*c*), 2–5 millimetres wide, and the diameter of the cylinder or spherical enlargement (*b*, *c*), amounts to 1·5–2·2 ctm.

If we blow a current of air through such a glass tube, without employing the flame as above, there will be produced only a roaring sound, in which there is perceived a tendency to the production of such a tone."

Note by Dr. Sharswood.—To those physicists, who may be inclined to take up the investigation of singing flames, etc., I would suggest, that, the phenomena may be most conveniently produced, by sounding two imperfect intervals in unison, on the flageolet. By two imperfect intervals in unison, I mean two-thirds in unison, one tuned a little flat of the other.

I subjoin a list of the contributions to Acoustics by Dr. Sondhauss. They have been mostly published as Programmes, and are therefore not generally accessible in this country.*

4. *Color of Blood Globules.—Editorial Note to Dr. Reuben's paper*, p. 328.—With regard to the color of single blood globules, it must be admitted that when individual blood globules are viewed under a magnifying power of from 600 to 800 diam., they certainly appear colored distinctly *yellow*, and not red. If now one or two plates of cobalt glass be placed under the stage, or over the eye-piece, the blood globules by virtue of their yellow tint, actually do cut off much of this blue light, probably not less than 50 or 60 per cent. They then appear much darker than the general field; their tint at first sight seems simply dark grey, attentive examination shows it to be dark bluish-green.

Compare also Herschel on the change of tint by an increase of thickness. Herschel on Light, Sect. 495.

In the 8th No. of the *Allgemeine Encyklopædie der Physik*, (Dec. 1860), Helmholtz details some observations of Purkinje on this subject, which agree with those of Prof. Wm. B. Rogers already published in this Journal. Helmholtz seems in doubt whether to attribute this appearance (seen with the naked eye,) to the flow of blood globules or to some other cause. He adds, "If this appearance has actually a connection with the circulation of the blood, we can admit at the most only, that single lymph corpuscles rich in fat and passing through some of the larger vessels, become visible in this manner."

5. *Subjective Optical Phenomena.*—In the London and Edinburgh Phil. Magazine, Jan. 1861, Sir David Brewster gives a short account of some optical experiments of a subjective nature. A blackened card provided with slits was moved rapidly before a circular aperture in the window shutter of a dark room; the aperture appeared then colored; reckoning from the centre, white or bluish, darker blue, white, dark ring, white, greenish yellow, reddish. It is unfortunate that neither he nor other observers have detailed the rates of motion they communicated to the slits, so as to render a comparison of observations possible. I infer from a slight repetition of these experiments that the rates were much lower than those employed by me. See No. 90 of this Journal, 1860.

He found also when the luminous impressions succeeded each other at a certain (long or short?) interval, that a hexagonal pattern was plainly visible. Compare a similar observation of *Purkinje*† under the same circumstances. Streams of moving particles have also been observed, and have been ascribed by Vierordt, to the blood circulation in the retina, becoming momentarily visible.† I have often caught distinct glimpses of this appearance.

O. N. R.

* (I.) Ueber die Schallschwingungen der Luft in erhitzten Glassröhern und in gedeckten Pfeifen von ungleicher Weite.—Ann. ch. u. Ph. lxxix, pp. 1-34.

(II.) Ueber den Brummkreisel und das Schwingungsgesetz der trobischen Pfeifen, —Jahresbericht K. Kath. Gymnasiums Breslau, 1850, pp. 3-37.

(III.) Ueber die beim Ausströmen der Luft entstehenden Töne.—Programme der Realschule zu Neisse, 1853, pp. 1-31, reprinted in Ann. ch. u. Ph. xci, p. 129, et infra.

(IV.) Ueber die Chemische Harmonika.—Programm der Realschule zu Neisse, 1859, pp. 1-43. (A very learned and full resume, together with valuable contributions to the subject).

† *Physiologische Optik*, by H. Helmholtz, 1860, page 381.

6. *On some illusions, and other phenomena, attendant on vision through colored media;* by SIMON NEWCOMB.—(1.) Let one put a red glass over the right eye, pressing it in so closely that little or no light can get to the eye except through the glass, hold a green or blue one over the left eye in the same manner, and thus look at surrounding objects in general for a few minutes. On removing the glass he will find that white objects will appear greenish when observed with the right eye alone, and reddish, or tinged with orange, when viewed with the left eye alone.

Evidently this illusion must be one of *sensation*, and not one merely of *judgment;* the term illusion (or error) of sensation, being applied to the case in which the impression actually conveyed to the mind is different from that ordinarily conveyed by the same exciting cause; and the term illusion or error of judgment to the case in which the mind forms an erroneous opinion respecting the nature of the impression. We are frequently, though not always, able to refer an observed illusion to one or the other of these two classes. Thus, in the case of the apparent enlargement of the celestial bodies when near the horizon, it is well known that the illusion is not in the impression of magnitude actually conveyed by the optic nerve to the brain, but that the mind, from a well known cause forms an erroneous judgment respecting the apparent magnitude. The above mentioned illusion resulting from observation through colored media is evidently one of sensation, because, the mind which judges being singular, would form the same sort of erroneous opinion respecting a sensation transmitted by one eye that it would respecting a similar sensation transmitted by the other. The glasses may be held so that it will be impossible for the observer to say which eye is covered by the red glass and which by the green one; yet on removing the glasses he can speedily solve the question by shutting the eyes alternately.

This phenomenon may be accounted for on the general principle that the increase of sensibility of the eye when placed for some time in darkness takes place independently with respect to the several colors of light; so that an eye from which all the red light is excluded will become sensitive to red light with equal rapidity whether light of other colors is admitted or excluded.

[This is analogous to the experiment of Count Schoffgotsch. His diploscope consists of a rotating disc painted half green, half red, and is observed through two tubes held before the two eyes. One eye becomes fatigued by the green light, the other by the red; if now the disc is set in rotation, the first eye sees only red, the other only green light. (See Eisenlohr, *Physik*, p. 327.)]

2. The two following experiments illustrate very finely the doctrine of corresponding retina points, and the inability of the eye to distinguish the organ by which observed sensation is conveyed.

With the glasses arranged as already mentioned look at a piece of white paper, having on it two spots, one of a very bright red, and the other of a very bright and pure green or greenish blue. If the left eye be closed the green spot will appear entirely black, while the red spot will appear so nearly of the general color of the paper as to be scarcely visible, and will not present the faintest indication of being red. If the right eye be closed the red spot will seem black, and the green spot will appear of

the color of the paper; but if both eyes be open, the spots will both appear of their natural color.

Under the same circumstances look at a white spot of paper with a single black spot on it. The spot will of course appear black, while the paper will be of those uncertain, mixed and ever varying shades which we know to be the result of looking at white objects in this manner. But, let the paper be now brought so close to the eye that two images of the spot may be seen. Instead of one or both images seeming black, that which corresponds to the black image as seen through the red glass will be of a bright green, while the other will be of a bright red. This is the result we ought to expect. To fix the ideas, and avoid troublesome phrases, let I represent the portion of the right retina on which the image of the spot falls, and I′ the corresponding portion of the left retina. Let J′ represent the portion of the retina of the left eye on which the image falls, and J the corresponding portion of the right retina. Call E and E′ all those portions of the respective retinas except L+I, and J+J′. Then the mind can make no distinction between the impression conveyed by L, and that conveyed by L′, and so of the other portions. From the arrangement of the glasses we have

On E red light,	on E′ green light;	result, an uncertain white.
On I darkness,	on I′ green light;	result, green.
On J red light,	on J′ darkness;	result, red.

These results correspond with the observed phenomena. It will be observed that the greenness of the apparent image of the spot seen by the right eye proceeds from the green light which falls on the corresponding point of the left eye, where it is not neutralized by the red light of the right eye. The result of the previous experiment is to be explained in a similar manner. [Compare Dove's experiment of looking at a green pattern on a red ground through red and green glasses. This vol., p. 109].

3. Suppose now that the green glass is removed, the eyes still observing a double image. It might then be supposed that the red image would preserve its color, since the nature of the light falling on the portions J, J′, of the retinas is not changed; and that the other image would lose all coloration, since it is now produced by white light on the one retina and darkness on the other. But the real result will be singularly the converse of this. The first image will lose nearly every trace of red, appearing almost perfectly black, while the second one will preserve its apparent greenness in all its brilliancy, though not a particle of green light (except what helps to form white,) can reach either eye! Vice versa, if the red glass be removed, the green image will change to black, while the red one will preserve its apparent color.

[No. 3 may be explained by the well known fact that when we look at an object placed so near the eyes that a double image is seen, the right image belongs to the left eye, and vice versa; also that a black object on a red field soon assumes a green tint, and *v. v.*]

CHEMISTRY.—

7. *Researches on the mutual relations of the Equivalents.*—With this title J. S. STAS has communicated the results of a ten years' laborious investigation, devoted specially to the examination of Prout's often dis-

cussed hypothesis. The memoir in question is one of extraordinary thoroughness and detail, which requires to be carefully studied, and does not admit of an abstract. Full details are given of the balances employed, of the methods of purification and analysis made use of; of the vessels used and the changes which they undergo; in short of all the precautions required to render the results as free as possible from errors of observation.

The result of this immense and conscientious labor is that *there is no common divisor* for the equivalents of the elements. In his own words, the author has attained "the full conviction, and so far as is humanly possible the perfect certainty, that Prout's law, together with the modifications introduced by Dumas, is nothing but a deception, a pure hypothesis."

The equivalents deduced by Stas are as follows:

Potassium,	39·154	from the decomposition of the chlorate.
Sodium,	23·05	
Ammonium,	18·06	
Silver,	107·94	
Lead,	103·45	from the synthesis of the sulphate.
"	103·46	" " " " nitrate.
Chlorine,	35·46	
Nitrogen,	14·04	
Sulphur,	16·03	

Berzelius found for potassium 39·150; Pelouze 39·156, and Marignac 39·161. By comparing the equivalents of ammonium and nitrogen in the table it will be seen that the difference is 4·02 instead of 4·00. As the equivalent of nitrogen was deduced from the synthesis of nitrate of silver, it follows either that this is inaccurate, or that the equivalent of hydrogen is inaccurate by the $\frac{1}{250}$ of its value. Stas considers the last as probable, and proposes to institute a new investigation of the composition of water.—*Recherches sur les rapports réciproques des poids atomiques, Brux.* 1860, quoted in *Jour. für prakt. Chemie*, 29, p. 65, No. 2, 1861.

W. G.

8. *On the polyatomic bases of the nitrogen, phosphorus and arsenic series.*—A. W. Hofmann has given some general views on the structure of the ammonia-derivatives which will serve as a useful guide in the study of the immense number and variety of new bases with which he has enriched the science. When dibromid of ethylene $C_4H_4Br_2$ reacts with a monamin, as for example with ammonia, either one or two molecules of the latter are fixed and there result two series of salts, one of which is monatomic and the other diatomic, and the composition of which is expressed in the following formulas:

I. Diatomic series.		II. Monatomic series.	
$\left.\begin{matrix}[(C_4H_4)'' \; H_6N_2]''Br_2 \\ [(C_4H_4)''_2H_4N_2]''Br_2 \\ [(C_4H_4)''_3H_2N_2]''Br_2 \\ [(C_4H_4)''_4 \quad N_2]''Br_2\end{matrix}\right\}$	Ethylene bases.	$\left.\begin{matrix}[(C_4H_4Br) \; H_3N]Br \\ [(C_4H_4Br)_2H_2N]Br \\ [(C_4H_4Br)_3H \quad N]Br \\ [(C_4H_4Br)_4 \quad N]Br\end{matrix}\right\}$	Bromethyl bases.

In the salts of the second series bromine may be eliminated either wholly or partially as bromhydric acid, formed either at the expense of water present—in which case the atomic group HO_2 replaces bromine—

or at the expense of ethylene itself, in which case vinyl compounds are produced. Two new groups are formed in this manner which may be formulated as follows:

III. Oxethyl bases.	IV. Vinyl bases.
$[(C_4H_4HO_2)\ H_3N]Br$	$[(C_4H_3)\ H_3N]Br$
$[(C_4H_4HO_2)_2H_2N]Br$	$[(C_4H_3)_2H_2N]Br$
$[(C_4H_4HO_2)_3H\ N]Br$	$[(C_4H_3)_3H\ N]Br$
$[(C_4H_4HO_2)_4\ \ N]Br$	$[(C_4H_3)_4\ \ N]Br$

From this it appears that the action of dibromid of ethylene upon ammonia produces sixteen bases, independently of intermediate and secondary products. The reactions are however much simpler with primary, secondary and tertiary monamins, the first class giving twelve, the second eight, and the third four bases. The author obtained the clearest expression of his theoretical views by operating upon triethylamin, triethylphosphin and triethylarsen. When these alkaloids are treated with dibromid of ethylene the following three groups of compounds are formed:

Nitrogen group.	Phosphorus group.	Arsenic group.
$[(C_4H_4)''(C_4H_5)_2N_2]''Br_2.$	$[(C_4H_4)''(C_4H_5)_2P_2]''Br_2.$	$[(C_4H_4)''(C_4H_5)_2As_2]''Br_2$

II. *Bromoethyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_4Br)(C_4H_5)_3N]Br.$	$[(C_4H_4Br)(C_4H_5)_3P]Br.$	$[(C_4H_4Br)(C_4H_5)_3As]Br$

III. *Oxethyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_5O_2)(C_4H_5)_3N]Br.$	$[(C_4H_5O_2)(C_4H_5)_3P]Br.$	$[(C_4H_5O_2)(C_4H_5)_3As]Br$

IV. *Vinyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_3)(C_4H_5)_3N]Br.$	$[(C_4H_3)(C_4H_5)_3P]Br.$	$[(C_4H_3)(C_4H_5)_3As]Br$

The bodies belonging to the second group, in the presence of other substances, yield very elegant reactions. Treatment with monamines, monophosphines, and monarsines transform them into an inexhaustible group of diammonium, diphosphonium, and diarsonium compounds on the one hand, and of phosammonium, phospharsonium, and arsammonium salts on the other. Polyatomic bases of a higher order result from the action of the diamines—ethylene diamines for instance—upon the bromo-ethylized salts.

The derivation of the oxethyl from the bromo-ethyl salts has already been mentioned. We have, for example, the equation:

$$[(C_4H_4Br)(C_4H_5)_3P]Br + H_2O_2 = BH + [(C_4H_4HO_2)(C_4H_5)_3P]Br.$$

The new salt bears the same relation to the bromo-ethyl salt which alcohol bears to bromid of ethyl. Hence, as might be expected, the oxethyl salt may be converted into the bromo-ethyl salt by distillation with pentabromid of phosphorus.

$$[C_4H_4HO_2)(C_4H_5)_3P]Br + PBr_5 = PO_2Br_3 + HCl + [(C_4H_4Br)(C_4H_5)_3P]Br.$$

The bromo-ethyl bromids may be regarded as tetrethyl compounds in which a molecule of ethyl has been converted into bromo-ethyl. Nascent hydrogen converts the bromo-ethylized bromids into tetrethyl bromids. Thus we have:

$$[(C_4H_4HBr)(C_4H_5)_3P]Br+2H=HBr+[(C_4H_4)_4P]Br.$$

In conclusion the author points out the possibility of obtaining triatomic, tetratomic and pentatomic bases, either by the action of ammonia upon more highly brominated bromo-ethyl bases or by the same action upon bases containing two, three or four equivalents of bromo-ethyl. Thus we might have the reactions indicated by the equations

$$[(C_4H_3Br_2)H_3N]Br+2H_3N=[(C_4H_3)'''H_9N_3]'''Br_3.$$
$$[(C_4H_2Br_3)H_3N]Br+3H_3N=[(C_4H_2)^{iv}H_{12}N_4]''''Br_4.$$

. . . . . .

$$[(C_4H_4Br)_2H_2N]Br+2NH_3=[(C_4H_4)_2''H_8N_3]'''Br_3.$$
$$[(C_4H_4Br)_3HN]Br+3NH_3=[(C_4H_4)''_3H_{10}N_4]''''Br_4.$$
$$[(C_4H_4Br)_4N]Br+4NH_3=[(C_4H_4)''_4H_{12}N_5]'''''Br_5.$$

Hofmann has already obtained a series of triatomic bases, of which diethylentriamin may be regarded as especially worthy of notice. The base has the formula

$$C_8H_{13}N_3=\left.\begin{matrix}(C_4H_4)''_2\\H_5\end{matrix}\right\}N_3$$

and is the first triacid ammonia. It forms magnificent salts, the chlorid being

$$[(C_4H_4)''_2H_8N_3]Cl_3.$$

—*Journal für prakt. Chem.*, No. 2, 1861, p. 110, and *Sitzungsberichte der k. Preuss. Acad. zu Berlin*, Oct. 1860. W. G.

9. *On the cyanid of Ethylene.*—Succinic acid bears the same relation to glycol which propionic acid bears to alcohol. As cyanid of ethyl by boiling with hydrate of potash yields ammonia and propionate of potash, it might be expected that under the same circumstances cyanid of ethylene would yield succinate of potash. Simpson has found that this is the case. The cyanid of ethylene, as prepared by the action of bromid of ethylene upon cyanid of potassium, is a semifluid brown and crystalline mass, easily soluble in water and alcohol. When boiled for some time with an alcoholic solution of caustic potash, ammonia is given off and succinate of potash formed. The reaction is expressed by the equation

$$C_4H_4Cy_2+2KHO_2+4HO=C_8H_4K_2O_8+2NH_3.$$

—*Zeitschrift für Chemie und Pharmacie*, Heft. 1, 1861, p. 14. W. G.

10. *On the separation of Mono- Bi- and Triethylamin.*—When iodid of ethyl is heated with ammonia, as Hofmann long since showed, all three ethylated ammonias are formed and these are difficult to separate. Hofmann now finds that the separation is easily affected by adding oxalate of ethyl to the mixed bases. This converts the ethylamin into diethyl-oxamid $\left.\begin{matrix}C_4O_4\\(C_4H_5)_2\\H_2\end{matrix}\right\}N_2$; the diethylamin into diethyl-oxamate of ethyl $\left.\begin{matrix}C_4H_4\\C_4O_3\\(C_4H_5)_2N\end{matrix}\right\}O_2$, but leaves the triethylamin unchanged. The diethyl-oxamid separates completely as a white crystalline powder while the other two remain fluid and are easily separated by filtration. These two

may then be separated by distillation, the triethylamin boiling at 91° C. and the ether at 260° C. The two oxamates may then be decomposed by caustic potash and yield the pure alkaloids.—*Zeitschift für Chemie und Pharmacie*, 1861, Heft. 1, 13. W. G.

TECHNICAL CHEMISTRY.

11. *On the Alloys of Copper and Zinc;* by FRANK H. STORER. (Concluded from p. 289.)

"One of the most common complaints against yellow-metal arises from a tendency which some specimens of it exhibit to become so friable, after an exposure of longer or shorter duration to sea-water, that the sheets may readily be broken in pieces, sometimes even between the fingers. Attention has recently been called to this subject by Bobierre,* who would refer such cases more particularly to chemical conditions depending, as he thinks, upon the too great proportion of zinc which is used in the preparation of the alloy, yellow-metal, as well as to changes of composition produced by hot rolling.

"I cannot agree with this conclusion. In my own opinion, the other alternative which Bobierre has suggested, namely, peculiar arrangement of the molecules of which the alloy is composed, furnishes the true explanation of the difficulty. It is, however, possible, that at times, when the temperature of the reverberatory, in which the alloy is heated before passing to the rolls, is not properly regulated, zinc may be burned off from the exterior portions of the sheet, and that the alloy richer in copper which would thus be formed may subsequently be pressed into the body of the sheet during the operation of rolling. An alloy destitute of homogeneity would result from this treatment which could hardly be durable in any event. Instances of this sort must nevertheless be rare, for no part of the process is watched by the manufacturers more scrupulously than this.

"It must also be borne in mind, that, of the enormous quantity of yellow-metal which is now used by the merchant vessels of Great Britain and of this country,—all of which is composed of sixty parts of copper and forty parts of zinc, and rolled hot,—only a comparatively small portion passes into the friable condition to which I have alluded.

"In most cases the alteration which the sheathing undergoes is gradual and regular, and the portion which remains after the wear of several years is still malleable. Indeed, the absolute amount of sheathing which becomes friable is entirely out of proportion with the annoyance to which it subjects ship-owners;† for it rarely happens, even in the worst instances, that more than one third of the sheets upon a vessel become friable, the remainder being in good condition.

"The friability is therefore a purely accidental occurrence, and by no means a necessary consequence either of hot rolling or of the presence of 40 per cent of zinc in the alloy, as has been implied by Bobierre.‡ I am strongly of opinion, that it might be in every instance entirely obviated by methodically annealing or tempering the sheets of alloy in such a manner that no fibres could form in them, and that their structure should be homogeneous.

"Bobierre in his very able thesis, to which I have already alluded, has urged that it would be well to discontinue the use of the alloy containing 60 per cent of copper, which admits of being rolled hot, and to substitute for it sheathing prepared from alloys containing about 66 per cent of copper, which can only be prepared by a most laborious process of cold rolling. It is true that the fibres which I have described would in this case probably never be encountered. Still there are several important

* Thèses présentées à la Faculté des Sciences de Paris.

Thèse de Physique: Des Phénomenes électro-chimiques qui caractérisent l'Altération, à la Mer, des Alliages employés pour doubler les Navires. Nantes: Imp. Busseuil. 1853. p. 61.

† Whenever the destruction of a portion of the sheathing requires that a ship be hauled up for repairs, it is customary, since this operation is an expensive one, to re-sheathe the vessel entirely: for as the friable sheets are interspersed among the others, and since all the sheets are somewhat worn, it would be bad economy to attempt any partial repairs. Of course the owner of the vessel regards the entire suit of sheathing as being worn out, and forms his opinion of the durability of yellow-metal in accordance with this view.

‡ Thèses, p. 77.

objections to the proposition of M. Bobierre. Not only would the method of cold rolling consume a much greater amount of time and labor; but it would be exceedingly difficult, if not impossible, to procure any alloy the composition of which could be maintained so nearly constant as is the case with yellow-metal.* It is not probable that a test like the one applied to this alloy could be found anywhere else in the whole series

"It is frequently stated in chemical text-books that yellow-metal is always prepared from "best-selected" copper, and one is led to infer that a metal of peculiar purity is alone used in its manufacture. This may once have been the case; but since the immense increase in the use of this alloy, it would no longer be practicable to obtain a sufficient quantity of copper of uniform character, or indeed of any one kind, from which to prepare the large quantity of sheathing which is used. In an establishment where expense would be a secondary consideration, as, for example, in a government workshop, it might still be possible to prepare an alloy constantly from the same sorts of copper and of zinc, in which case, although the amount of zinc lost would probably be subject to considerable variations, one might, nevertheless, soon be able to control the process, and to prepare an alloy of the composition proposed by Bobierre, so that only trifling variations should occur in the composition of the product. But in ordinary practice manufacturers are compelled to make use of the most varied kinds of copper, not only because the supply of the best sorts is limited, but particularly from the fact, that, owing to the competition which exists between the various founderies,—or rather, by force of the laws which regulate supply and demand,—they are obliged to remelt large quantities of old copper sheathing,† the origin of which is unknown to them, and which may have been originally prepared from copper of inferior quality.

"Now since many of the impurities of copper are eliminated when it unites with zinc, being thrown up on the surface of the melted metal as a crust or scum which is removed by the workmen,‡ and as no two samples of copper contain the same kind or quantity of impurity, the amount of it removed, or, what is the same thing, the amount of copper left to unite with a given weight of zinc,§ must continually vary.

"From this it may easily be seen how very difficult, if not impracticable, it would be to obtain anything like constant results, unless some test were found by which the workman might ascertain at least approximately the composition of his alloy.‖

"That it is of the first importance that every alloy used for sheathing shall possess some one constant composition, so that it may endure equally well on all parts of the vessel, and that no voltaic action may occur between the metal of different sheets, is a point too obvious to be mentioned.

"It might still be urged against yellow-metal, that the admixture of other metals —of kinds capable of mingling with it—which may have been derived from the copper used in its preparation, is a serious objection to its use. This is true, and the remark applies with equal or even greater force to all the alloys used for sheathing; it must always depend upon the condition of copper metallurgy. It would apply more forcibly, for example, to the low grade brass which Bobierre has proposed to substitute for the ordinary sheathing metal; for since the "test" by means of which founders are enabled to prepare the alloy—yellow-metal—of constant composition

* An alloy of constant composition might, however, possibly be prepared, by adding known quantities of melted copper to determined volumes of molten yellow-metal which had been prepared by the usual method.

† The popular notion, that a better—"more compact"—product is obtained by *remelting* any alloy, may also have some connection with this custom.

‡ This explains the remark of Karsten (*loc. cit.*, § 386), that perfectly pure copper can take up from 1·5 to 2·5 per cent more zinc than impure, and still afford a product of better color, more tenacious and more malleable.

§ Much zinc also is lost in this case, both by alloying with the foreign metal and by uniting with any oxygen which may have been combined with the latter. As the workmen say, impure copper "burns up" a great deal of zinc.

‖ It must be well understood, however, that as a rule manufacturers of alloys of copper and zinc always use the best copper they can obtain, since it is generally more economical for them to do so For the purer this metal is, so much the greater will be the total amount of alloy obtained by the use of a given weight of it, or, in other words, the loss, mentioned in the preceding notes, which would occur from elimination of impurities, will be smaller.

cannot be obtained if metals are present which are incapable of mixing in all proportions with this alloy, in which event small particles of the foreign substances would be found irregularly disseminated upon the fractured surface of the test ingot, manufacturers are enabled to ascertain at once whether or no a given sample of copper is suitable for the preparation of yellow-metal. Whenever it is found that satisfactory tests cannot be obtained, the copper is immediately rejected by the founders, and applied to some other use. No similar means of controlling the purity of the brass in question are known.

"It does not appear—at all events it has never been proved—that any serious injury results in practice from the use of the most varied kinds of copper, so long as they afford the desired *homogeneous* alloy containing 40 per cent of zinc.

"I do not wish to deny that hurtful impurities may at times occur in yellow-metal, in spite of the test to which I have so frequently alluded. Most probably the very rare cases in which this alloy wears out irregularly, portions of the sheet being much corroded, while other parts are scarcely at all acted upon and have preserved their original color and malleability, may be referred to the irregular diffusion of such impurities throughout the mass of alloy of which the sheet was formed;* but their influence must be regarded as being of very slight importance in comparison with the changes of structure which have already been discussed."

A detailed account of the method of analysis employed [humid assay by means of iron] and a list giving the composition of the different alloys examined, follows. As also, comments upon the violent action which is observed when zinc and copper enter into combination with each other, and upon the remarkable tendency to separate into layers, according to their relative specific gravity, without combining, which these metals exhibit when not mixed together by stirring.

"It is doubtless this tendency of the metals to remain unmixed in separate layers when not subjected to agitation, which has led several chemists to believe that the alloys of copper and zinc are apt to separate by eliquation into two portions respectively rich in copper and zinc; from which they have inferred, as I have previously remarked, the existence of definite compounds."

The color of the alloys is next considered.

"The most contradictory statements have been made by different observers in regard to variations of color among the alloys of copper and zinc. In the specimens which I have myself prepared, no abrupt change or peculiar modification of the true color is to be perceived, although some very striking superficial characters present themselves. Starting from the red of pure copper, the color of the alloys is less red and more yellow in proportion as they contain more zinc, until an alloy containing 75 or 80 per cent of copper is reached, the color of which is almost pure yellow; beyond this point, as the proportion of zinc contained in them is increased, the alloys become less yellow, with perhaps a tinge of green, and more white continually, and this by the most gradual stages, until the well-known white alloys are reached. These remarks refer to the color of polished surfaces as obtained by the use of a fine file."

In several of the alloys however, especially in those containing about equal parts of copper and zinc, a beautiful yellow or sometimes gray irid-

* It is not impossible that the small amount of silver which, as is well known, is precipitated from sea-water upon the metallic sheathing of ships, can accumulate to such an extent in yellow-metal which has been repeatedly used and remelted, that the durability of the latter may be seriously impaired thereby. It is, however, equally probable, and perhaps more so, that the greater part of this silver is eliminated in the preparation of the alloy, when the old metal is fused with zinc.

escent film forms upon the surface of the metal during the process of cooling. This is probably due to oxydation.

"Marked changes not only of color but also in other of the physical properties of some of these alloys may be produced by varying the conditions in which they pass from the liquid to the solid state. These changes are very peculiar and are evidently of great importance, not only in their practical bearing, but also from affording another instance of the phenomena of 'tempering' which may possibly be of consequence in the study of this most difficult subject."

"In preparing the white alloys containing less than 45 per cent of zinc, I have frequently observed, upon the under surface of the sheet obtained by pouring off the liquid alloy, a thin layer of a soft, tenacious, malleable alloy, of a yellow color. The formation of this singular sheet was at first attributed to eliquation; but as it was difficult to conceive that an alloy apparently richer in copper should remain at the surface of the melted mass in the crucible,—which must have been the case in order that it should form the bottom of the ingot,—it was thought possible that volatilization of the zinc might have increased the proportion of copper at the surface of the melted alloy. In order to decide this question, a new series of alloys was prepared, extending from the one obtained by melting together 40 parts of copper plus 60 parts of zinc, to the mixture of 56 parts of copper and 44 parts of zinc; —each alloy being made from a mixture containing one per cent more copper than that used in preparing the preceding. After thorough stirring, the alloys were cast into ingots of about five pounds' weight. In the first four of these alloys—from 40 to 44 per cent of copper—the yellow film was very clearly defined on the three sides of the ingot which had come in contact with the metal of the mould, while on the upper surface of the ingot, which had cooled in contact with the air, no trace of it could be detected. This yellow film is usually of extreme tenuity, hardly exceeding one-sixteenth of an inch in thickness in any of the instances which I have observed. It is, however, so very clearly defined in the white alloys containing 40 to 45 per cent of copper, being readily bent, cut, or filed, while the remainder of the alloy is exceedingly hard and brittle, that no question as to its identity can possibly be entertained. In the alloys containing more than 50 per cent of copper, which are naturally of a yellow color, it is not so easy to detect a similar film. In the series of ingots just mentioned, it could nevertheless be traced as far up as the alloy prepared from 54 parts of copper plus 46 parts of zinc.

"An experiment made in order to ascertain whether this soft modification of the alloys could be obtained at will, afforded no positive result. An alloy of 42 parts of copper plus 58 parts of zinc being prepared, a portion of it was poured by small drops into a large mass of cold water. The surfaces of many of the granules thus obtained were covered with a yellow film, and this was especially true of the smallest pieces; but the film was exceedingly thin, and the interior of the granules consisted entirely of brittle white alloy. Other portions were thrown out upon cold iron plates, so as to form very thin sheets. A thin yellow film occurred, it is true, upon the inferior surfaces of these sheets, but above it the alloy was white and brittle. Another portion of the melted alloy was cast in an iron ingot-mould which had previously been heated "black-hot." The yellow film was still formed where the alloy came in contact with the ingot-mould; it was, however, exceedingly thin. On pouring some of the remaining alloy into a cold iron mould, a yellow film of the usual thickness was obtained.

"Although the phenomena of tempering exhibited by these alloys are more readily perceived among those the normal color of which is white, it is highly probable that all the alloys are liable to have their physical properties influenced to a greater or less extent from this cause. This would appear, not only from the evident analogy of these phenomena with those which are known to occur with alloys of copper and tin;* but Dussaussoy† has already shown that ordinary brass, copper 65 to 70 per

* *Vid.* d'Arcet in *Dictionnaire de l'Industrie Manufacturière, etc.*, x, 500, Art. *Tam-tam* (Paris, Baillière, 1841); also, *Ann. Ch. et Phys.*, (2.) liv, 331. See also Dussaussoy, *Ann. Ch. et Phys.*, (2.) v, 225.

† *Loc. cit.*, p. 226, *et Tableau* No. 5.

cent plus zinc 30 to 35 per cent, is rendered softer, less tenacious, and less dense by tempering it;—a fact which Mallet* has very properly urged in explanation of the differences between several of the specific gravities of alloys of copper and zinc observed by himself, and the numbers which had been previously obtained by other experimenters. I would here suggest that it explains equally well the very great variations among the specific gravities of the different alloys studied by Mallet himself.† It is also the most probable explanation of the alloys of abnormal color which he has described. I should observe in this connection, that in the alloys of light yellow color the yellow appears to be made much deeper when the alloy is strongly compressed, as when cut with a cold-chisel or hammered. I may also incidentally mention, that in the series of alloys which I have prepared, a constantly increased degree of hardness has been observed, in proportion to the amount of zinc contained in the alloy,—at least as far as the brittle white alloys, which are so hard that an ordinary file makes little or no impression upon them;‡ a result which agrees with those of Karsten,§ of Mallet,‖ and of Guettier.¶ Calvert and Johnson** have recently attempted to express these differences numerically. The alloy containing 54 per cent of copper, which is still so tenacious that small bits cannot readily be broken from it, was found to be exceedingly difficult to cut with a cold-chisel; for though still so soft that it could be filed without any very great trouble, it destroyed at once the edges of cutting instruments, though the latter were well tempered. This peculiarity appears to be connected with the fibrous structure of the alloy."

12. *Preparation of Oxygen on the Great Scale.*—In addition to the new methods of obtaining large quantities of oxygen which were reported on page 280, DEVILLE and DEBRAY have now published an elaborate article containing the details of their labors upon this subject to which we would call the attention of technological chemists. In this memoir, which forms a part of their remarkable monograph upon the metallurgy of platinum, &c., they have studied the comparative merits of all the industrial processes of manufacturing oxygen which were known heretofore and of the methods which they have themselves devised,—with a view of enabling any manufacturer to decide which process may be best suited to the locality or circumstances in which he happens to be situated. They describe also a method of preparing oxygen from chlorid of lime which seems to be well adapted for laboratory use,—when heated to low redness, chlorid of lime (bleaching powders) gives off, per pound, from twenty to twenty-five litres of oxygen. This gas is mixed with a little chlorine, from which it may be freed by washing with an alkaline solution, or better, the formation of this impurity may be prevented by adding enough slaked lime to the chlorid employed that this shall be strongly alkaline; if this precaution be attended to, the operation may be conducted in iron vessels. It is of importance only to avoid heating the mass to the fusion

* *Loc. cit.*, p. 264

† I have found it impossible to construct a curve of any regularity from the observations of this chemist, although it is tolerably clear that the greatest condensation is at a point somewhere below the alloy composed of equal equivalents of copper and zinc, and that between this point and pure copper the specific gravity gradually increases with some degree of regularity in proportion as the amount of copper increases. Among the observed specific gravities of the white alloys rich in zinc, there is no regularity whatsoever. The determinations of Mallet are, nevertheless, unquestionably the best which have ever been made; possibly they are the best which could be made in any case. At all events, few chemists are in the position to improve upon the method of preparing alloys which was employed by this distinguished observer.

‡ From this category the alloys modified by tempering must of course be excepted.

§ *Loc cit.*, S. 393.

‖ *Loc cit.*, p. 307; also Gmelin's Handbook, (Cavendish Soc. Edit.,) v, 479.

¶ *Loc. cit., passim.* ** *Loc. cit*, p. 199.

point of the chlorid of calcium. The calcination may even be made in glass vessels. The production of oxygen from this source is very regular and unattended with danger. The process is moreover economical as compared with those commonly employed by chemists;—in the experiments of the authors the cubic metre [35·316 cubic feet] of oxygen when prepared from black oxyd of manganese cost about four francs, from chlorid of lime five francs, while from chlorate of potash it could not be obtained for less than ten francs; but the process is nevertheless far more expensive than their sulphuric acid method, the cubic metre of oxygen having cost in this case not more than one or two francs,—and in practice the price would probably be much less than this, since the sulphurous acid might readily be utilized.

It is worthy of remark that the oxygen prepared from sulphuric acid can be easily obtained in a state of chemical purity.—that made from black oxyd of manganese is always contaminated with nitrogen.—*Ann. de Chim. et Phys.*, [3], lxi, 97, Jan., 1861.

13. *On the "Sweet Fermentation" of Milk.*—On the occasion of a discussion, upon the conditions requisite for the preparation of butter, which took place at the meeting of the convention of Swedish Agriculturalists, in 1858, it occurred to Prof. Alexander Müller of Stockholm, that the simplest explanation of the multifarious appearances which must be noticed and the precautions to be followed in the preparation of good butter, was to be found in the supposition that the original albuminous envelopes of the fat globules in the milk must undergo a solvent fermentation before the butter can be collected. In proof of this view he now offers experimental results, of which the following table is an abstract: As Mitscherlich proved long ago, ether dissolves only mere traces of fat when shaken with milk as it comes from the cow, and dissolves so much the more fat in proportion to the length of time that the milk has been kept.

This milk, which for the sake of convenience had been diluted with an equal volume of water, gave up to ether in the *m*th hour after milking, in the *v*th hour after it had been diluted with water, and after it had been mixed with ether for one hour,* *f* per cent of fat.

No.	*m.*	*v.*	*f.*
1*a.*	2	1	0·55
b.	14	13	1·28
2*a.*	18	1	0·85
b.	38	21	1·52
c.	61	44	2·08
3*a.*	65	1	2·56
b.	86	1	4·52
c.	109	1	4·56

The temperature of the laboratory during these experiments was 15° C. [=59 F.]. No. 3*a*, curdled while being shaken with ether, 3*b*, and 3*c*, were already sour; the other samples were fresh and sweet when treated.

[* By long continued digestion with ether the author shows that much larger amounts of fat than those indicated in the table may be obtained. This has however no immediate bearing upon the point in hand. F. H. S.]

Although the specimens came from three different milkings, the results may nevertheless be regarded as a continuous series of determinations of the solubility of the fat in milk which had been kept from two to 109 hours. The solubility of the fat increased with the age of the milk, from 0·55 per cent in that kept for two hours, to 4·56 per cent in that kept during 109 hours, evidently in consequence of the destruction of the envelopes of the particles of butter, which had meanwhile been going on. It is probable that this solution of the coverings of the particles of butter is attended with oxydation, for the air of the vessels in which the milk was preserved contained less oxygen at the close than at the commencement of the experiment; from the experience of dairies it is also to be inferred that the solution of the envelopes of the particles of butter is retarded both by low and by high temperatures. Perhaps this solution is independent of the ordinary acid fermentation, but a more probable suggestion is that the envelopes of the fat globules may be the substance which excites the acid fermentation of the milk sugar, in one stage of which the caseine is coagulated.

The described solution,—or rather alteration, which the author proposes to designate as the "sweet fermentation (*Süsse Gährung*) of milk" must be of importance in explaining the rationale of the preparation of butter,—in which the chief object is to accumulate the fat particles without at the same time collecting any admixture of caseine.—*Journal für praktische Chemie*, lxxxii, 13, 1861, No. 1.

14. *Products from the combustion of Gunpowder under different pressures;* by B. F. Craig.—The perusal of the paper of Bunsen and Schiskoff on "The Chemical Theory of Gunpowder," whose publication about two years ago attracted much attention, (This Jour., [2], xxvi, 106), led me, as it no doubt did others, to make some experiments on the residues of exploded powder.

The investigations of the above-named chemists were made on the products of gunpowder which had been burned in small quantities, and under very slight pressure, and, in concluding their paper, they advance the supposition, that, under a difference of circumstances, the products may be essentially different from those which were obtained by themselves.

Such is actually the case, for the solution obtained by washing a gun with well boiled distilled water, immediately after its discharge, and filtering while hot, will be found to contain sulphuret of potassium with very small quantities of other substances, while Bunsen and Schishoff found their residues to consist mainly of sulphate and carbonate of potash. This difference is what was to be expected from our knowledge of chemical laws, and it is also to be observed that the products of combustion in the gun vary somewhat, according as the explosion takes place under a greater or less pressure. Thus in firing with a shot very heavy in proportion to the charge of powder, as in firing a mortar, the washings of the piece are found to be of a bright green color, while the ordinary washings of a gun are colorless after the suspended carbon has been allowed to settle, or has been removed by filtration.

The color above spoken of, is exactly the tint of a solution of a sesquisalt of chromium; it is not impaired by filtration of the liquid, but disappears in a few hours by exposure to the air, and immediately by the

action of acids. The cause of this color seemed to me at first obscure, but I found that by adding a very minute quantity of freshly precipitated sulphuret of iron to solution of protosulphuret of potassium, the same color was produced, and a sensible trace of iron may always be found in gunpowder.

A greenish color is frequently observed when sulphuret of iron is precipitated in the presence of an alkaline sulphuret, but as it disappears on standing, it has been commonly attributed to the presence of particles of sulphuret of iron held in suspension, an opinion which must be erroneous, since I have obtained a solution of iron in sulphuret of potassium of an intensely green color perfectly clear and transparent, and permanent for many days in a sealed tube.

Why this green compound should be formed under some circumstances, and not under others, in a mortar, and not in a cannon, is not insusceptible of explanation.

It has been shown that when powder is exploded under slight pressure the alkaline metal remains in large part as a sulphate, but under higher pressure and corresponding temperature, it is reduced to the condition of a sulphuret. Now, by analogy, it would seem, that with the ordinary charges of a cannon or musket the iron is not reduced to the state of sulphuret, but if, as is often the case in a mortar, the projectile is fifty times the weight of the powder, or upwards, the gases are brought to a state of great tension before the shot moves, and in that state of things the carbon is completely converted into carbonic acid, and the iron, as well as the potassium, brought to the condition of sulphuret.

Smithsonian Laboratory, Washington, D. C., Oct., 1860.

15. *On the Amounts of Lead contained in some Silver Coins;* by Eliot and Storer.—The determination of the amount of lead in American silver coin was suggested to the authors by finding half of one per cent of lead in a sample of zinc such as is used at the United States mint for reducing chlorid of silver. (See their Memoir on the Impurities of Commercial Zinc in Memoirs Amer. Acad., [n. s.], viii, 61; also this Journal, [2], xxxi, 142). For the sake of comparison other coins were subsequently examined.

Kind of coin.	Per cent of Lead in the coin.
1 American half-dollar of 1824,	0·310
20 " five-cent pieces of 1853,	0·209
10 " ten-cent " of 1854,	0·228
2 " twenty-five cent pieces of 1858,	0·231
"Fine Silver" from the U. S. Assay Office in N. York, 1860,	0·161
1 Spanish dollar of 1793, Carolus IV,	0·056
1 Mexican " " 1829,	0·043
2 English Shillings of 1816,	0·485
1 French five-franc piece of 1852, Napoleon III,	0·428

On the supposition that the zinc used in the reduction of the silver is the source of the lead in the American coin, the authors calculate the amount of lead which would thus find its way into the coin. Their memoir, already cited, gives the per cents of lead found in two specimens of Vieille Montagne zinc; if zinc of the best quality (containing 0·292 per

cent of lead) had been used, the silver coin would have contained 0·158 per cent of lead; if the second quality (containing 0·494 per cent of lead) had been employed, the coin would have contained 0·268 per cent of lead. Between these two limits all their determinations of lead in American silver coins lie. In offering this explanation of the occurrence of lead in American silver coin, the authors would by no means affirm that the zinc is the exclusive source of this impurity, for it is not at all improbable that a portion of the lead is derived from the leaden vats in which the reduction of the chlorid of silver is effected, or from the sulphuric acid which is used to excite the reaction. The process of analysis was such as to permit the separation of the gold contained in each kind of coin. A distinct button of metallic gold was obtained in every instance, before the blowpipe, but the amount of gold varied to a considerable extent; it was abundant in the American and Spanish coin, less was observed in the English and Mexican, and but little in the French coin or in the American fine silver. Brüel has remarked "that the process of separating lead and silver was less perfectly executed in the ages of antiquity than is at present the case." (*Karsten u. Dechen's Archiv. für Mineralogie, etc.*, 1844, xviii, 509), yet in none of the recorded analyses of ancient silver coins has any one detected so large an amount of lead as the authors have shown to occur in American fine silver of the year 1860, if a single analysis of Prof. Draper's be excepted which gave nearly three per cent of lead in a silver coin of Hadrian. It is probable however that the methods of analysis—none of which are recorded—employed for separating lead from silver by other chemists, were less delicate than those which the authors made use of and have fully described. The occurrence of lead in the American silver coin could probably be mainly, if not altogether, avoided, by employing zinc free from lead, such as is produced at the Zinc Works of Bethlehem, Pennsylvania. It is noteworthy that the American system of amalgamation, which has been so frequently criticised by European metallurgists, affords silver which is less strongly contaminated with lead, and is probably purer in other respects, than is produced by any other process of manufacture.—*Proceedings of the American Academy*, V, 52, Cambridge, Sept., 1860.

II. GEOLOGY.

1. *Botanical and Palæontological Report on the Geological State Survey of Arkansas;* by Leo Lesquereux.—This is a separate issue of the Botanical portion of the second Geological Report of Arkansas, just published, from p. 297 to 399, large 8vo, with five good plates representing new species of fossil plants from the Coal formation and one of fossil-leaves from the Tertiary. We regret that the separate title page is not dated. Considering that the operations recorded in this paper were made during a single, hasty, autumnal reconnaisance of the State of Arkansas, it is one of unusual interest and importance, and its plan may well be adopted for more thorough surveys under better auspices, especially as to what relates to the recent Botany, and general distribution of the plants of Arkansas. This part is introduced by the following appropriate—

"*General Remarks.*—The distribution of the plants of a country, according to the nature of its geological formations, is extremely difficult to settle with any chances of reliability. It has been asserted with apparent reason:

1st. That it is still uncertain if the chemical elements of the soil, even if it was proved that they are directly depending on the nature of the underlying geological strata, have a perceptible influence on the vegetation which naturally covers any peculiar place. That, in any case, the amount of influence which the chemical constitution of the soil exercises upon the distribution of the vegetation is still problematical.

2d. That the geological elements, viz., the particles resulting from the decomposition of the rocks and entering into the composition of the soil, even if their influence on the vegetation were well marked, are generally disseminated by water and atmospheric agency to a great distance from the areas occupied by the formations from which they come. The lime of a limestone ridge, the sand of a mountain of sandstone are carried down the declivities, spread over other kind of rocks, transported to the alluvial plains, or deposited on the banks of rivers and thus mixed together in a peculiar compound which, in its new state, has but an indirect relation to the rocks from which it is derived, and no relation whatever to the formations which it covers. Moreover, the frequent alternations of strata of sandstone and of limestone which compose the rocks of the great valley of the Mississippi, Silurian, Devonian, Carboniferous, and Tertiary, prevent an exact limitation of the area over which each of them may extend its influence. Thus, it has been generally admitted that physical circumstances more actively govern the distribution of the vegetation of a country than can chemical constituents of the rocks. Consequently, that the direction of the ridges, the amount of light and atmospheric heat and moisture, the thickness of the soil, its hardness and capacity for retaining water, are the essential causes of the distribution of the plants.

These considerations may be true, but they touch only one side of a complex and difficult question which cannot be discussed now. If the hardness, compactness of a soil, its capacity for retaining water and heat, are essential causes affecting the distribution of the plants, it is evident that this cause depends principally on the chemical nature of the geological strata. On the other hand, if the dissemination of the geological elements renders the task of ascertaining their influence difficult in some places, it is not a reason to reject as useless or impossible any attempt to compare the vegetation of a country with its geological formations. If this comparison can be made anywhere with a chance of success, it is certainly in Arkansas, where the strata are nearly horizontal and extend over vast areas.

The exploration of the Botany of Arkansas began too late and was too short to permit the fulfilling of a work which for its completion would require some years of continual research. The following data collected along our road of travel can thus be considered only as the first points of delineating lines which may be continued and completed hereafter."

Under the head of the Mammoth Spring of Fulton County, Mr. Lesquereux notices the rank development of aquatic vegetation which it supports, owing to the temperature of the water, constantly 60° Fahr., and the amount of air it is surcharged with. It would be well to know what proportion of this air is carbonic acid. The short section on the prairies of Arkansas is of such general interest that we cite the whole.

"*Prairies of Arkansas.*—Before entering into the examination of the botanical distribution characteristic of the part of Arkansas which I explored, there is still a peculiar question which cannot be easily treated elsewhere, and which calls at once for an examination.

The Prairies of Arkansas do not appear to have been formed all in the same manner. They are underlaid by different formations, situated at various elevations, and their general aspect differs apparently so much, that it looks as if a peculiar law had directed the formation of each of them.

I have explained elsewhere* the general formation of the prairies, and ascribed it to the agency of water. All the prairies still in a state of formation along the great lakes of the North are nothing else but marshes slowly passing to dry land by slow recession of water. When land is continually covered by low stagnant water, its only vegetation is that of the rushes and of the sedges. When the same land is alternately subjected to long inundations and then to dryness, during some months of the year, the same plants continue to cover it. By their decomposition these marshy plants produce a peculiar ground, either black, light, permeable when it is mixed with sand, as it is near the borders of the lakes, or hard, cold, impermeable when it is mixed with clay or muddy alluvium, as in some marshes underlaid by clay or shales, or along the banks of some rivers. Land continually covered with stagnant water cannot produce any trees, because the trees require for their growth, like most of the terrestrial plants, the introduction of atmospheric air to their roots. Neither do trees germinate and grow on a ground alternately covered with stagnant water and exposed to dryness for some months of the year. From these considerations, the law of the general formation of the prairies can be deduced: While a land or a part of a country is slowly passing from the state of swamp or marsh to the state of dry land the annual alternative of stagnant water and dryness causes the vegetation of peculiar plants, which, by their decomposition, form a peculiar soil unfavorable to the growth of the trees. From this general rule of formation, which regards only the prairies of the Mississippi valley,† all the different phenomena or peculiar appearances of the prairies can be easily explained.

The prairies of Arkansas, following their vegetation and their geological connection, may be separated into three classes:

1st. The prairies of the North, mostly underlaid by cherty limestone.

2d. The prairies of the West, on carboniferous shales and clay.

3d. The prairies of the South and East, overlaying tertiary and alluvial formations.

1st. The limestone prairies of North Arkansas mostly belong to the counties which are examined in the next division. They are singular in this fact, that their surface is not always flat, and that they are mostly placed on soft declivities or coves along or between the ridges. They are mostly of small extent and surrounded by thickets of low trees. The compact or somewhat porous Subcarboniferous Limestone which they cover does not absorb water with rapidity. Hence, in the spring, water percolates slowly along the slopes, taking with it the detritus of the stone, and depositing it where its course is either stopped or slackened. A scant swamp vegetation springs up there, its decomposed remains are mixed with the original deposit, which, by and by, augments in thickness under the action of water and of vegetation. This soil is naturally spongy, preserves water for a part of the year, like the peat, which it resembles, and thus cannot sustain trees. They establish themselves on a firmer ground all around. When by successive contribution of limestone deposited by water and of particles of humus received from the plants this soil has become thick enough, it is, when drained by a few ditches (serving as channels for the water of the rainy season), a fertile and easily cultivated ground. The channels of drainage are generally formed by a natural depression, the depth of which varies with the thickness of the soil of each prairie. In this case, as coarser materials are of course heaped on the banks of these creeks, a few

* Bulletin of the Society of Natural Sciences of Neuchatel (1856).

† The prairies of the far West, along the eastern base of the Rocky Mountains are true sandy deserts, caused by the dryness of the atmosphere.

trees grow along them. They are mostly stunted specimens of the Post-Oak, the Rock Chestnut Oak, the Persimmon, the Mockernut, the Juniper, and a shrub, *Bumelia lanuginosa*, Pers. The characteristic herbaceous plants of these limestone prairies are especially: *Ambrosia polystachya*, *Kuhnia Eupatorioides*, *Aster sericeus*, *Croton capitatum*, *Grindelia lanceolata*, *Palafoxia callosa*, *Oxibaphus albidus*, &c., species which are not found on the prairies of other formation. Besides these plants they are covered with a great number of species belonging to the prairies in general.

Between this and the second division of the prairies, viz., of those which are formed on the Carboniferous shales and clay, there is a remarkable transition, which unites both divisions, or rather shows their common origin. In the western parts of Benton and the northern part of Washington counties some flat prairies, formed like those of the second division, and underlaid by shales or red clay, have still at their surface some isolated patches of Subcarboniferous cherty limestone, which appear here and there, breaking the general horizontality like small mounds. Possibly these low mounds could support the vegetation of the trees, and they may have been transformed into prairies by the influence of fire, which is a secondary agent of their formation. But the soil which covers them is exactly of the same nature as the soil of the surrounding prairies, and as their height is no more than two or three feet, they may have been formed in the same manner and by the agency of water.

The prairies on the Carboniferous shales are generally flat, surrounded by hills, or at least by a higher border, which gives them the appearance of the bottom of drained lakes. These prairies are of various extent, and although they may overlie different kinds of ground or geological formation, in Arkansas they are generally underlaid by Carboniferous fire-clay or shales. In the spring they are covered with water which cannot percolate, and become true marshes for a time, and have the vegetation of marshes: the rushes and the sedges. This semi-aquatic vegetation gives, according to the nature of the underlying strata, either a hard, compact, cold soil, by decomposition of shales or clay; or, when mixed with sand, the peaty black soil of the prairies of Illinois and of the Northern States. In the summer months, these marshy prairies become dry by evaporation, and as it happens with the prairies of the first section, the alternative of too much water and of dryness in the soil prevents the growth of trees.

These prairies are more sterile or rather more difficult to cultivate than those of the former section, as we shall have occasion to see when examining the counties of Sebastian, Franklin, &c., where this kind of prairie is mostly found. A few trees,—the Water Oak, the Pin Oak, the Honey Locust,—grow along the creeks which meander in their middle. The soil is, in its natural state, mostly covered with the great Compositæ of the prairies and the hard grasses, species of Beard-grass and Broom-corn.

The prairies of the third class are extensively formed in Arkansas on the Tertiary or Alluvial land bordering some rivers of the South, especially Red River. Our exploration did not extend to that part of the State. It is very probable that these prairies have been formed in the same manner and by the same agency as those of the other sections. From the catalogue of Mr. Nuttall, who explored these plains, their plants appear somewhat different from those of the other prairies. They rather bear the character of a Western Flora, or of the Flora of the plains extending toward Mexico."

Then the geological nature of the soil, and the general characteristics of the vegetation, the agricultural capabilities, &c., of different districts of the State are considered in succession, and lastly, there is a catalogue of the plants of Arkansas, as far as known, systematically arranged, their Latin names, their English names, Geological station, and natural hab-

fact, being given in parallel columns, with well-chosen remarks upon properties and uses appended in foot notes.

The Palæontological part, noting that all the coal-beds of the State appear to belong to the lowest member of the Coal-formations, briefly mentions the characteristics of different beds examined, and describes 18 new species of plants from their overlying shales, and enumerates 50 others which have been elsewhere found. Leaves of a new supposed *Magnolia*, of a *Rhamnus*, and of a *Quercus*, are described and figured from a tertiary deposit. A. G.

2. *Prof. Heer's reply to Dr. Newberry on the Age of the Nebraska Leaves.*—The article of Dr. Newberry in this Journal, xxx, p. 273, having a few days ago come to my notice, calls for an answer from me, although it is with great unwillingness that I enter into controversy.

The point of dispute is known to be on the plants discovered in Nebraska. Dr. Newberry had remarked in relation to them (cf. *On the so-called Triassic rocks of Kansas and Nebraska by Meek and Hayden, this Journal*, [2], vol. xxvii, p. 33); 'the species of your fossil plants are probably all new, *though generally closely allied to the Cretaceous species of the old world*,' and, to prove this, he quotes the following genera: Sphenopteris, Abietites, Acer, Fagus, Populus, Cornus, Liriodendron, Pyrus?, Alnus, Salix, Magnolia, Credneria and Ettinghausenia. I took the liberty of remarking, that according to my views, the two last named genera were not correctly defined, and that the rest of the genera, quoted by Dr. Newberry are represented in the Tertiary and not in the Cretaceous. On this Dr. Newberry founded his charges, which, though answered already by Mr. Lesquereux, he repeats again. I allow myself to reply to them as follows:

1. In relation to the Credneria Dr. Newberry seems now to admit, that the leaves from Nebraska cannot be assigned to this genus, as he himself says: it may prove a new genus. In fact, all the characteristics of Credneria are wanting in these leaves, (to wit: those fine lateral veins, which stand out rectangular, proceeding from below the rigid secondary veins.) This very characteristic caused Mr. Stichler to compare them with Coccolaba, whilst the leaves from Nebraska are very similar to those of *Populus leuce*, Rossm. sp. In this comparison I had not only examined the drawings of Rossmæssler and Unger, but also fine leaves of that species which were sent to me from Bognasco and Sieblos. The margin of these leaves is only sparingly dentate or even entirely toothless, and also only slightly wavy or undulate. I cannot agree to Dr. Newberry's Ettinghausenia any more than in regard to the Credneria. All the leaves of this genus, which are known to me, are serrate or dentate toward the apex, the leaf from Nebraska, on the contrary, has its blade divided into three lobes, and these have an even margin. This leaf seems to me rather to belong to Sassafras, of which genus Massalongo has one species presented in beautiful plates (in his *Studii della flori fossili del Senegagliense*). The same species (*S. Feretianum* Mass.) I have received from Merat, only the lobes in this are much shorter; of a second species (*S. germanica*, M.) I have a representation in my work on the flora of Skopau (cf. *Beiträge zur Flora des sachs. Braunkohlen*). A comparison of the drawings of the Nebraska leaf (in the Proceedings Acad. Nat. Sci. Phil-

adelphia, Dec. 1858, p. 223, Fig. 3.) with these Tertiary Sassafras species, and also with the Ettinghausenia, will satisfy every one that it is much more like the former and probably, therefore, is to be assigned to that genus. In relation to the separation of Ettinghausenia from Credneria, I did not intend to pronounce it in my letter to Mr. Lesquereux as unjustified. But Mr. Stichler certainly will willingly concede, that with the present materials it is impossible to establish this genus in a satisfactory manner; for Mr. Stichler himself has found cause to add the sign of interrogation to more than half of the species, mentioned by him among the Ettinghausenia. Dr. Newberry's assigning such a deviating form of leaf to this genus, proves the correctness of what I have said. Mr. Stichler has characterized excellently and circumscribed more strictly the genus Credneria, and separated from it a number of deviating leaves, which put us more in mind of Cissus, and has united them under one common name (as Mr. Bronn has done already before him). But at present it is impossible to characterize in a satisfactory manner this group of leaves, which itself seems to embrace very different elements. Wherefore it can justly be said, that this genus has no value whenever it is desired to fix the age of a certain formation, while, on the contrary, the several species of it may be of great importance in the decision. Therefore, I do not think that I have done injustice to Mr. Stichler by my having said so much in a letter to a friend, which letter was not intended for publication. That Dr. Newberry feels himself called on to appear as the defender of Mr. Stichler amuses me. The thought of offending Mr. Stichler never entered my mind, having lived for years in habits of friendly scientific intercourse with him, and holding his works in the highest esteem.

2. But if the Credneria and Ettinghausenia are now left out of the flora of Nebraska, and if the leaves so interpreted belong rather to the Tertiary than to the Cretaceous genera, the question may be put, on what grounds can the assertion of Dr. Newberry be established: that these plants ally themselves closely to the Cretaceous species of the Old World? As we remarked above, Dr. Newberry mentions besides Credneria and Ettinghausenia, eleven other genera, to the list of which he afterwards adds Platanus. These are all, however, well known Tertiary genera and several of them bear an important part in the Tertiary flora. Two of them (*Sphenopteris* and *Abietites*) are not of any importance in this discussion, being present in nearly all the formations and therefore not peculiar to any one of them; but this is not the case with the rest of them. Dr. Newberry now maintains, that several of these are contained in the work of Stichler (*über die Kreideflora des Hayes Palæontographica*, v, 23), and puts the alternative that either I have not known the work of Stichler, and am, therefore, not competent to give an opinion upon it; or I have known it, and a severer expression would be justified. To this I have to reply, that Mr. Stichler, in the work mentioned, describes only the genera: Credneria, Ettinghausenia, Weichselia, Pandanus, Pterophyllum, Delesserites, and mentions *Salicites? fragiliformis*, etc., and *Juglans Humboldtiana;* but in the introduction, (p. 50), he mentions, that Mr. Apothecary Hampe gives the following additional genera: Chondrites, Halymenites, Equisetum, Pecapteni, Flabellaria, Pinites, Geinitzia, Arau-

carites? Comptonites, Salicites, Populus, Alnites, Acer? and Quercites. Mr. Stichler, however, says, (p. 50), *that most of these vegetable remains need further examination, which was not possible, until more perfect specimens were on hand, and he enumerates expressly certain insufficiently determined genera:* viz. Comptonites, Salicites, Populus and Alnites. Mr. Stichler, therefore, does not enter into those at all, although his work treats on the very flora of this locality, and this evidently only for want of material for a description in any way adequate. These are precisely the genera to which Dr. Newberry refers, and for which he reproaches me, as either not having taken notice of, or else of willingly ignoring them. I confess freely, that in my opinion it is not possible to build such important conclusions on such uncertain data, and that it were better to lay them aside until a somewhat more correct solution is possible. But if, for argument's sake, we should accept these definitions of Mr. Hampe, based upon incomplete materials and pronounced unsatisfactory by Mr. Stichler himself, Dr. Newberry's position is not thereby bettered, as that list contains only two of the genera mentioned by him, Populus and Acer, and this last one, Stichler himself designates immediately afterwards as Acerites? That Acerites is not the same as Acer, Alnites not Alnus, and Salicites not Salix, it is surely not necessary to argue any further at present. They designate only similar forms of leaves, which, however, are so incompletely preserved, that a stricter definition could not be formed, as Mr. Stichler himself shows, that Salicites fragiliformis is not a proper Salix, but is better to be designated as Phyllites. It is true, Messrs. Gœppert, Reuss and Dunker mention saliciform leaves in the Cretaceous formation, but in none of all the now known species are the veins sufficiently preserved to enable us to recognize in them the characteristics of the Salix: the definitions, therefore, have to remain yet unsettled.*

Mr. Ettinghausen is of the same opinion; (cf. *über die Proteaceen der Vorwelt, S.* 3), according to him *Salicites angustus* Reuss belongs to *Grevillea*, *Comptonites antiquus* Nils., however, to *Dryandra*. Thus stands the matter in relation to those genera, which, according to Dr. Newberry, Nebraska has in common with the Cretaceous formation. Six of Dr. Newberry's genera, however, (Fagus, Cornus, Liriodendron, Pyrus, Magnolia and Platanus), are not mentioned at all, either by Mr. Stichler, or in any work on the Cretaceous flora. Therefore, I do not feel that I deserve the reproaches of Dr. Newberry, while at the same time I consider myself justified in declaring again, on the present occasion, that the very genera mentioned by Dr. Newberry himself argue in favor of the Tertiary flora and not of the Cretaceous, and that, consequently, his assertion, that the Flora of Nebraska is closely allied with the Cretaceous of Europe, is not supported by the evidence. It is entirely incomprehensible to me,

* The *Salicites Hartigi* Dunk., cannot belong to Salix: not only are the shortened lateral veins different, but also the terminations of the secondary veins. In Salix they form arches, not reaching the margin, while in these Salicites (at least in the drawing), they reach the margin. *Salicites Potzeldianus* Gœp., (Nov. Act. Acad. Lœp. xix, t. 47; fig. 18), Mr. Gœppert himself considers as very dubious. In this species occur also those shortened lateral veins characteristic of the willows. *Carpinites arenaceus* Gp., (l. c. Taf. 47, fig. 19, 20) cannot be compared with Carpinus; the secondary veins terminate in arches.

how he can say "the fossil flora of Blankenburg is indeed strikingly like that of our lower Cretaceous strata," (this Journal, [2], xxix, p. 211),—a flora so wholly different from the present European and American, while living representatives still occur in America of nearly all of the now known genera of the flora of Nebraska.

3. If the relations of the strata and the fossil remains of animals make it indubitable that the fossiliferous sandstone in Nebraska and Kansas belongs to the Cretaceous formation, it follows of course, that these plants have to be assigned to the Cretaceous flora. In this case the interesting fact would present itself, that the Cretaceous flora of America differs entirely from that of Europe, and is more closely related to that of the middle Tertiary. The Coal flora of America corresponds in many of its most important types with that of Europe, as shown by the excellent works of Mr. Lesquereux, likewise the flora of the Keuper, as we learn from the distinguished labors on these plants by E. Emmons; further, the Miocene flora of Vancouver shows the most striking relationship with the Miocene flora of Europe; the Cretaceous flora, therefore, would form a remarkable exception. We must, of course, not forget, that the Cretaceous flora of Europe has not been as yet extensively examined, and that many new forms will doubtless yet come to light. The Tertiary flora shows such an abundance of Dicotyledons, that in all probability many more of its typical genera than are known at present have their original forms in the Cretaceous epoch, among them, perhaps, some of those which came to our knowledge from Kansas and Nebraska. It is, however, worthy of notice, that the Eocene flora of Europe, (i. e., that of Monte Bolca, of the Isle of Wight, of St. Zacharie in Provence, and of Skopau), does not contain those genera mentioned by Dr. Newberry (with the exception of Acer), and that they do not make their appearance in Europe before the lower Miocene epoch, while, on the other hand, they are entirely missing in Aix, the richest spot for Cretaceous plants known, although the sands and clays of Aix belong to the upper Cretaceous formation (*Turonienne*); wherefore we must suppose here a nearer approach to the Tertiary flora, than in the lowest Cretaceous, to which the formation of Nebraska is said to belong. The materials before us enable us to assert, that the Cretaceous flora of Europe has an entirely different character from that of Nebraska, and I will try to prove this more satisfactorily.

We have in the Cretaceous flora of Europe, numerous and mostly peculiar Filices, differing in type from the present European forms. We notice among them beautiful Gleicheniaceæ, (one genuine Gleichenia), and large Danæaceæ, among which the superb Weichselia reminds us of Anomopteris of the varigated sandstone, and which, with several more extinct genera, (Moriconia, Benizia, Bonaventura, Manheimia, etc.), gives the Cretaceous forms a peculiar feature. Among Monocotyledons we meet Palms, Pandaneæ and Scitameneæ, (Cannophyllites); among the Gymnospermæ also a considerable number which remind us of the Cycadeæ of the Jurassic flora, (Cycadites, Pterophyllum, Pterozamites, Microzamia and Zamiostrobus), and numerous peculiar Coniferæ, of which the genus Cycadopsis, (*Geonitzia*), related to Sequoia, has spread very largely. With this, and with those forms which are closely allied to the Indio-Australian

Damaræ, Cunninghamiæ and Arancariæ, are mixed (according to epistolatory communications from Dr. Debeg), several most peculiar extinct genera; the Dicotyledons, which, as is well known, appear first in the Cretaceous formation, present themselves in the lower chalk only in few, (namely in Credneria and Ettinghausenia), but in the chalk of Aix, in numerous species. According to the communications from Dr. Debeg, to whom we owe an excellent work on these plants, (cf. *die urweltlichen Thallophyten und Acrobryen, Denkschriften der Wiener-Academie*, xvi, and xvii), he has discovered in Aix about 200 species of Dicotyledons. Among them are prominent the Proteaceæ, (60–70 species), Grevillea, Hakea, Banksia, Persoonia, and some other Dryandreæ, appearing among them; but also the Myrtaceæ, are pretty numerously presented, (Eugeniæ, Eucalypti, and Leucospermum), whereas the Leguminosæ are entirely wanting. Among the Amentaceæ appear the genera Ficus and Quercus, and of the Juglandeæ Gœppert has already made known the fruit of a walnut-tree. But those leaves also described by Dunken as Cytisus [Cretaceous] belong in my opinion to Juglans and Carya.* This flora of Aix shows, therefore, a decided Indio-Australian character, and approaches thereby the Eocene flora, while that of the older Chalk formation is foreshadowing the transition to that of the Jura. How different the flora of Nebraska appears, having all the now known genera in common with the Miocene flora, and all the dicotyledoneous generic types met in America at the present time! If it really belongs to the oldest Chalk formation, the flora of that epoch would closely ally itself to the present flora of America, and there had (judging by the small amount of materials) since that time not occurred any new arrangement which had materially changed the genera, while this was the case in Europe in a high degree. Many peculiar forms join the older Jurassian types in the lower Chalk, and the Dicotyledons appear mostly in now extinct genera; after this the flora assumes more and more the Indio-Australian character, which continues through the Pliocene flora to the commencement of the Miocene; then the Indio-Australian types retreat by degrees into the background, making room for the American, this prevailing to the end of the Miocene epoch, and, in single species, reaching into the Pliocene, while in the Quaternary epoch the Asiatic types make their appearance, with the present creation, predetermining the character of the vegetation. No doubt it is possible, that the American flora has assumed from the Cretaceous period an entirely different development from that of Europe; but ere we accept such a remarkable phenomenon as a fact, we had rather wait for further examinations of the localities where the Nebraska leaves are found. I must confess that I cannot suppress my doubts about the correctness of the classification of them, and I appeal to the experience we have had in Europe. How easily accessible are our Alps in comparison to the parts of America in question, and how long a time did it take, before we were correctly informed on the relations of the strata of the most important formations; and how much are we in the dark yet about some parts of those very mountains! It is now generally admitted, that with us older formations are resting on Tertiary for an extent of over 36 miles. "There

* They cannot belong to Cytisus, because the secondary veins project too much; they have, however, the character of walnut-leaves.

exists," says Studer, (*Geologie der Schweiz*, ii, f. 4), "in this mountain group of several square leagues, the wonderful arrangement, that Flysch and Nummulite-sandstones, which we have learnt to recognize as the last sediment-formation in the system of the Alps, here appear in the foundation of the Verrunaco, of the Jura and of the Chalk-formation, not otherwise as we are used to see gneiss and mica-slate in other parts of the Alps or in the palæozoic formations in other mountain systems." If Dr. Newberry could visit the Glärnisch, (Canton Glarus), on the eastern slopes of which true Jurassic to a great extent lies over nummulitic chalk in a nearly horizontal position, he, perhaps, also would find, that, without the shadow of a doubt, one must believe the Nummulitic-chalk older than the Jura.

I cannot close this note without expressing my deep regret for having been obliged thus publicly to defend myself against Dr. Newberry. There are so few men engaged in the study of fossil plants, and the field is so immensely extensive, that it would be better to devote our time to this work, and not to useless disputes. I have, however, not sought this discussion, and only entered into it compulsorily; and I hope that in future I may meet Dr. Newberry, who has already rendered to science such important services, on more pleasant grounds. OSWALD HEER.

Zurich, Dec. 15, 1860.

3. *On the causes which gave rise to the generally elongated form and parallel arrangement of the pebbles in the Newport Conglomerate;* by Prof. WILLIAM B. ROGERS (from Proc. Boston Sci. Nat. History).—Referring to the characters of the conglomerate as presented at Purgatory and other places in the vicinity of Newport and indeed generally throughout its outcrops, Prof. Rogers commented on the hypothesis by which it had lately been proposed to explain the elongated form and parallel arrangement of the pebbles in the massive strata of the rock. He described the steep and alternating dips of these thick beds of conglomerate at and near Purgatory, as made apparent by the occasional layers of interposed sandstone, and pointed out the general parallelism there and elsewhere of the flat sides of the pebbles to the planes of deposition as well as the prevailing uniformity of direction of their larger axes.

He urged that such an arrangement of the pebbles corresponds precisely with the effects of *wave and current action* on water-worn and partially water-borne fragments during their accumulation. The large proportion of pebbles of elongated shape met with in these beds was, he considered, the natural consequence of the mode of disintegration of the original metamorphic rocks from which the pebbles were derived. Such rocks, in virtue of sharply intersecting joints and cleavage planes are prone in many localities to break up in long irregular somewhat rhombic figures which by the wearing action of streams and tides are easily converted into oblong pebbles like those of the Newport conglomerate. Examples of this mode of disintegration are common in the more altered belts of the Appalachian region, especially among the silicious and argillaceous slates along the southeastern border, and may be seen at various points among the similar altered rocks of New England.

To the hypothesis of Prof. Hitchcock (see Prof. H.'s paper in this No.) that these elongated pebbles owe their peculiar shape and position to the

action of powerful pressure upon the strata while the pebbles were in a soft condition from intense heat or other causes, Prof. Rogers urged the following objections :

1st. The effect of pressure upon a plastic solid, as shown by Sorby and Tyndal, is in all cases to develope more and more distinct cleavage planes throughout the mass, these planes being uniformly at right angles to the direction of the pressing force. Such an action applied on a large scale to the strata of conglomerate must therefore have had the effect not only of flattening the plastic pebbles in a uniform direction, but of developing a cleavage or lamination in them all, parallel to their flat sections as they lie in the mass. But this is so far from being the fact that we find the cleavage planes of different pebbles running in wholly different directions, sometimes across, sometimes parallel, and sometimes oblique to the general bedding, just as might be expected from the preservation of the original cleavage-structure of the rock from which they were derived.

2d. Such a moulding of the pebbles by pressure would either enormously distort or entirely obliterate any fossil forms or impressions which may have existed upon or within the pebbles at the time of their deposite. But an inspection of the Lingulæ from the Taunton River conglomerate and of a similar fossil found subsequently by Mr. Easton in the conglomerate of Newport shows that no such violence could possibly have operated on the mass.

3d. While in the localities referred to the *majority* of the pebbles have the oblong shape and parallel arrangement above described, there are many scattered through the mass, which are either nearly round or have their longer dimensions more or less transverse or even perpendicular to the general direction. As these could not have escaped the enormous, all-pervading, softening action and pressure which the hypothesis assumes, their presence in these discordant conditions seems of itself a sufficient refutation of the theory.

In regard to the curved form and close adaptation observed in some of the pebbles, Prof. Rogers thought that accidental peculiarities of shape in the original fragment and the effects of attrition and the close packing of the accumulated deposit furnished an adequate explanation both of the bent form sometimes met with and the accurate fitting of the contiguous pebble to the concave surface.

As an example of the formation of flattened pebbles by the action of the shore waves, Prof. Rogers referred to the paving stones of slaty trap recently imported from Newfoundland, which are remarkable for their very uniform circular outline, their smooth, slightly convex faces and a thickness rarely exceeding one-third of their breadth. If we suppose a great mass of these, as they lie piled along the shore with their broad sides horizontal, to be hereafter cemented together as a stratum of conglomerate rock, would not the argument founded on their shape and position be even stronger than in the case of the Newport conglomerate? Yet nothing is more certain than that they owe their shape and arrangement to the peculiar movement and attrition to which they have been subjected by the action of the waves.

Thus as regards the Newport rocks and most other conglomerates which had fallen under his notice, Prof. Rogers saw no difficulty in refer-

ring the form and arrangement of the pebbles to the familiar agencies indicated. He does not however doubt that in some highly metamorphic districts, conglomerate rocks are to be found which have sustained great internal changes through the effects of heat, chemical action and violent pressure. Such he has long thought must have been the conditions in some parts of the Blue Ridge and South Mountain chain in the Middle States, and such perhaps were the influences which operated on the Gneissoid conglomerates of the Green mountains, to which Prof. Hitchcock has referred in his recent communication to the Society.

MINERALOGY.—

4. *Note on Chloritoid from Canada;* by T. STERRY HUNT, F.R.S.—Among the crystalline Palæozoic schists of the Notre Dame Mts., which are the Canadian prolongation of the Green Mts., of Vermont, is a rock characterized by the presence of a mineral which has been designated in the Reports of the Survey by the name of phyllite, from the supposition of its identity with a similar mineral from Massachusetts, described, named and analyzed by Thompson. The mineral in question is abundant in a fine grained grayish wrinkled micaceous schist from Brome and in larger specimens from Leeds; where it occurs in a similar rock which is pearl gray in color, passing into greenish gray, and contains a large proportion of quartz with a mineral talcose in aspect, but aluminous in composition, and apparently micaceous. Similar micaceous schists containing the mineral in question may be traced in the continuation of the Notre Dame Mts., as far as Gaspé. In the rock of Leeds the phyllite occurs in small lamellar masses rarely more than one-fourth of an inch broad and one-eighth of an inch thick. In some specimens it forms spherical aggregations half an inch or more in diameter composed of radiating lamellæ and sometimes making up one-half the volume of the rock. In most localities however the masses are smaller and less abundant. The mineral has a perfect cleavage in one direction and two less distinct transverse cleavages, 'the lamellæ are often curved and are not easily separable. Hardness 6·0, density 3·513, color dark greenish-gray to black; brilliant black on the surfaces of perfect cleavage which have a vitreous lustre; the cross-fracture is granular and exhibits a feeble waxy lustre. The streak and powder are greenish gray. The mineral resembles somewhat a dark colored variety of hypersthene.' The analysis of a carefully selected specimen from Leeds gave as follows:*

Silica,	26·30
Alumina,	37·10
Protoxyd of iron,	25·92
Protoxyd of manganese,	·93
Magnesia,	3·66
Water,	6·10
	100·01

This analysis shows the mineral to be chloritoid, with which its specific gravity and other characters agree. It is the *barytophyllite* of Breithaupt, the *masonite* of Jackson and the *sismondine* of Delesse. All of these minerals occur in argillaceous, micaceous or chloritic slates and

* Report of Geol. Survey of Canada, 1858, p. 194.

having a hardness of 5·0—6·0, and a density of 3·45—3·57, have been united with chloritoid, with which they agree in composition. (Dana, *Mineralogy*, ii, 298).

The phyllite of Thompson according to the analysis of that chemist contains a larger amount of silica than chloritoid together with more manganese, and 6·80 p. c. of potash, but having had occasion to repeat several analyses of this chemist, I have found that his determinations of alkalies are entirely erroneous. Thus in the case of raphyllite a tremolite containing only traces of alkalies he indicated more than ten per cent of potash and in his retinalite, a pure serpentine, nearly nineteen per cent of soda.* In both cases the error was at the expense of the magnesia of the mineral. The substance examined by Thompson has not so far as I know been examined or identified by American mineralogists, but in the minerological cabinet of the Laval University at Quebec, is a specimen from the collection of the late Mr. Heuland; said to be phyllite from Massachusetts, which is evidently chloritoid, and cannot be distinguished from the specimens of that mineral just described; the rock is also apparently identical.

The ottrelite of Haüy, to which Dana has referred the phyllite of Thompson, occurs in an argillaceous slate in Belgium, and in a specimen before me cannot be distinguished from the phyllite from Massachusetts or the chloritoid of Canada. This mineral has however been analyzed by Damour, whose name is a guarantee for accuracy, and differs from chloritoid in containing a considerable excess of silica, which might possibly be derived from the gangue. The specific gravity which Damour has assigned to ottrelite is 4·4—which is so extraordinary for a mineral of that composition that we are led to suspect some error probably of the press or pen. The question of the identity of ottrelite with chloritoid is one which requires farther examination. Meanwhile the latter mineral assumes some importance to the lithologist as characterizing over wide areas considerable masses of schists, which we have elsewhere described as chloritoid slate.

III. BOTANY.

1. *Journal of the Proceedings of the Linnæan Society; Botany.* No. 18 (1860), contains, (1.) Notes on *Ternstræmiaceæ*, by George Bentham, V.P.L.S. A critical survey of the order (for which we could have wished that the name *Camelliaceæ* were adopted), in which Mr. Bentham retains the *Saurauieæ*, and to this refers *Stachyurus*, very properly reducing *Draytonia* to *Saurauja*; also the *Gordinieæ* or proper *Camelliaceæ*, and the *Bonnetieæ*, to which he joins the genus *Marila*; and finally he makes of the *Marcgraviaceæ* another tribe of the same order. The known species of *Cairapa* are described in a note, with several other new plants of Spruce's collection.

(2.) Mr. Crocker, a foreman in Kew Gardens describes the curious germination of *Streptocarpus polyanthus* and a few other *Cyrtandreæ* of similar peculiarities. In the adult state, the plant above mentioned has only one leaf,—a radical one—and this, as Mr. Crocker shows, is one of the cotyledons, which from a microscopical size expands in germination

* Report of Geol. Survey of Canada, 1850, p. 40.

and at length becomes about a foot long, the flowerstalks springing from its sinus. The two cotyledons grow equally for the first few days, but one of them is soon arrested while the other grows on in this remarkable manner. *S. Rexii* and *S. biflorus* show this remarkable peculiarity, but also develope a plumule of two or three smaller leaves.

(3.) The Notes on *Anonaceæ*, by George Bentham, indicate the principles adopted in the forthcoming revision of this order for the new *Genera Plantarum*, and characterizes several new species. The rather numerous instances in which the petals are imbricated in æstivation, as in *Magnoliaceæ*, are mentioned, and the æstivation is (perhaps rather too much) used in the division into tribes.

(4.) *Botanical Memoranda*, by George Bentham. In this short paper Mr. Bentham discusses several topics with his well-known ability and good sense. We must demur to his conclusion that the so-called involucre of *Anemone* answers to a single amplexical divided leaf, and would refer to the involucels of two opposite leaves in *A. Virginiana* and *A. Pennsylvanica* in proof of the contrary; nor can we regard the change from alternate to opposite or verticillate leaves as so anomalous or so unusual as in itself to give likelihood to the new hypothesis. The more elaborate ensuing note on the stigmas of *Papavaraceæ* is clear and admirable.

(5.) On *Fissicalyx*, a new genus of *Dalbergieæ* (No. 2223 of Fendler's Venezuelan collection), by the same author.

(6.) Account of the plants collected by Dr. Walker in Greenland and Arctic America during the expedition of Sir Francis M'Clintock in the Yacht 'Fox,' by Dr. J. D. Hooker.

(7.) *Hepaticæ India Orientalis*, by Mr. Mitten; commenced.

Supplement to vol. v.; *Botany*, 1860, contains the *Florida Adenensis*, by Dr. Thomas Anderson, a botanist of excellent promise; 43 pages, with 6 plates. Ninety-four species compose the known phænogamous flora of this arid little peninsula of Aden, belonging to 79 genera and 41 natural orders. Most of these species are scarce in individuals, only a few of the more arid forms predominating; all are more or less peculiar in their habit, and destitute of a bright green color; nearly all are glaucous, whitened, or hoary, many are fleshy, and 16 bear sharp thorns. "All the species have to strive against conditions tending to the entire extinction of vegetable life;" and "the flora appears to be a collection of desert species, selected from widely different natural orders and genera, and all alike contending with the excessive heat and drought." "In so dry a climate, Ferns and other Cryptogamia except Lichenes, are quite unknown." A. G.

Review.—

2. *Life on the Earth, its Origin and Succession;* by John Phillips, M.A., LL.D., F.R.S., late President of the Geological Society of London, Professor of Geology in the University of Oxford. Cambridge and London, Macmillan & Co., 1860, pp. 224, 12mo.—A book with this taking title, especially in these days, is sure of a prompt and wide circulation,—all the more so when the author is an Oxford Professor, and a Rede Lecturer at the sister University. The subject and the author here command attention and respect, and excite a high degree of expectation. We imagine that those readers who take this volume for what it really is, viz.,

an amplification of "the Rede Lecture," delivered in the year 1860, before the University of Cambridge, and as a popular exposition, by an able geologist, of an interesting scientific topic—will not be disappointed.

On the other hand, those who take it,—as the title-page might lead them to do—either for an original speculation upon the Origin and Succession of Life on the Earth, or for a serious and sustained criticism of the particular hypothesis which Mr. Darwin has recently propounded, will hardly have their expectations satisfied. Yet, along with a large amount of very good elementary exposition, some considerations are adduced, and some points are made, which are extremely noteworthy, and which show how well Professor Phillips could have discussed the whole subject, at least in its geological bearings, if he had seriously undertaken it.

The best point, as it strikes us, which Professor Phillips makes against Darwin is drawn from a comparison of fresh-water with marine Mollusca,—the latter of numerous and widely diversified types, and of great change on the whole from age to age; the former of comparatively few types, and much alike all over the world and throughout geological time as far back as they can be traced.

"If, in either of these cases, the Unionidæ, the Paludinadæ, the Limnæadæ, Planorbes, Physæ, &c., the modern forms are derived from the ancient, we have the full measure of the whole variation,—the differentials of change are all integrated by time, and we behold the sum —how little! But if not so, if the modern and ancient species have sprung from different branches of a stem still older than either, how much stronger, if possible, is this decisive testimony against the doctrine of indefinite change through time and circumstance! Circumstances have varied, ages have passed away, and yet every generic group exhibits at every step the same essential characters, and many of the little peculiarities, such as eroded beaks, plications on the surface, reflexions of the lip, carinations of the whorls, which cannot be consistent with accumulated tendencies to change, (p. 113). "The discovery of a land-shell allied to if not identical with Pupa, in the interior of a fossil tree (Sigillaria) in the coal-formation of Nova Scotia," (p. 116), is an analogous case.

To enforce the argument we need the statement,—which we wonder Prof. Phillips has not adduced, and which we suppose may be safely ventured upon,—that fluviatile and terrestrial conditions must all along have been more variant and diverse, and therefore more favorable to the eduction and natural selection of variations according to the hypothesis, than marine. Yet while, under the comparatively uniform conditions of the latter, every thing 'doth suffer a sea-change into something rich and strange," the freshwater and terrestrial genera remain almost unaltered. Put in this form, the objection appears to us a formidable one, which we should not know how to answer. Yet, on the whole, there is, as there should be on the theory, a far greater diversity on land than in salt water. The common form of similar objections misapprehends the theory, by assuming that actual variability is something constant and equable—a uniform and measurable force acting always and upon entire species—so that so much time should bring to pass so much change; or else, that the external conditions really produce the variation;—while, also, that *com-*

plex which is condensed and rather boldly personified by the term Natural Selection is no better comprehended by many naturalists than is the Malthusian theory by many political economists.

In view of the fact that a large number of existing species appear (by the evidence of their remains) to have existed from near the beginning of the pleistocene or quaternary epoch, and that the difference between the fauna of that period and the present consists merely in the extinction of a number of species, Mr. Pictet convincingly argues that the actual geological epoch, the present creation, began at the close of the tertiary. Professor Phillips would seem to go farther; for, in view of the similar, though less universal identifications by which "the tertiary series is linked in easy harmony with the actual period," he concludes that; "The present age is in fact a part of the great cænozoic period," (p. 169, 170), under which term, as the preface informs us, he "comprehends not only the eocene, miocene, and pleiocene of Lyell, but the whole series of supra cretaceous deposits." Looking then at "examples of parallel forms of Mammalia now living with some of the tertiary quadrupeds once denizens of the same regions, or regions formerly connected by land," or where, "without this close affinity, a considerable resemblance is found between special tribes now living and others fossil in the same region," as in a part of America "among the Edentata, which though not quite confined to that region, are more plentiful there than elsewhere, and are successors of fossil races also found almost exclusively in that country;" noting also that the marsupial mammals of Australia had marsupial predecessors, our author continues:—

"The peculiarity indeed is of far earlier origin; for it occurs in the eocene deposits of the basin of Paris, in the lacustrine deposits over the upper oolite at Stonesfield, and probably in the Trias of Wurtemberg. In respect of the Stonesfield fossils, this is not the only evidence presented by that curious deposit of similarity of mezozoic life in the north and cænozoic life in the antipodal region of the south. It extends to other groups, both of the land and sea, and almost justifies the notion of some affinity even in the systems of life. For just as at Stonesfield, so in Australia, small insectivorous marsupial mammals are associated with Cycadaceous plants and Ferns; as now in the seas surrounding Australia, Terebratula and Rhynchonella, Trigonia and Cucullæa, consort with Turtles and the Cestracion Sharks, near reefs of coral, and rivers tenanted by Gavialian Crocodiles, so at Stonesfield in the older time, similar animals in similar combination.

"What does this teach us? Are we looking upon two partially similar, but really separate creations suited to partially similar conditions in very different periods of time? Or is the life-system of the modern Australian land and sea truly derived in some of its components by descent with modification from the older periods of the world, and preserved to this our day, notwithstanding displacement over half the circumference of the globe, and all the vicissitudes of an immensity of time?" (p. 171, 172).

The author proceeds to answer these questions in the following passages in which his volume culminates:

"Whoever has the courage to adopt the latter view must accept with it the obvious inference, that, in all the countless ages which have rolled away since the branches [?] of Zamia were blown into the lagoon at Stonesfield, the amount of organic change has been small in each group of plants and animals; that a similar amount of change affected the unlike inhabitants of land and sea; that Mollusca and Sharks, and Turtles and Crocodiles, have all been modified by differences of a small description in passing from Oolitic to modern times, while not only hosts of Ammonites and Belemnites have perished in the experiment, but many new forms, as Oliva, Mitra, Triton, Struthiolaria, unknown in the earlier period, have come into view in the latter. But let it be adopted. What follows? These small differences then, accomplished in all that prodigious range of elapsed time, under all that variety of physical changes and removals, these are all the mutations which have been possible under the constant tendency of hereditary descent to perpetuate similar forms with modification.

"One of these genera, that of Trigonia, is known to be in the fossil state rich in species. Supposing them all to have come from one original typical form, the differences which they show in strata of the same system, deposited within the same grand period, and under much similarity of conditions, argue a facility in giving variations: let this operation be supposed to be continued in the interval between the epoch of Stonesfield and that of Australia, and the effects summed by natural selection, the result is the modern *Trigonia*, scarcely differing more in appearance from the fossil species than they differ one from another. But, if not so derived by continual descent, but sprung from separate contemporaneous branches of one stem of life, how should it happen that plants and quadrupeds on land and mollusks in the sea, should in each of these two cases pass with equal advance along the streams of change, moving in one case so fast, in the other so slow? But if the branches sprang at different times and led to these similar results, would this double origin in time, for several similar forms in similar associations, fit with the hypothesis of continual development?"

This is neatly put. But it seems to be founded on the supposition that variation in descent is somehow *caused* by time and change, and goes on by something like equal increments in equal times; whereas, the cause of variation is wholly occult,—the fact is, that some forms remain long invariable or slightly variable under the same conditions in which others vary freely. If Mr. Darwin's theory is bound to explain variation, or to assign a reason for one species varying when another does not, then it utterly fails, for it can do no such thing. If, however, it does not undertake to account for the diversity of species except by regarding them as varieties of earlier origin and wider divergence,—leaving the reason why the progeny is sometimes unlike the parent in one or more particulars as much unexplained as why it is usually like it, but showing how the struggle for life ensures the extinction of crowds of intermediate forms, and now the resulting natural selection may lead certain surviving races farther along the lines of favorable variation,—then it avoids the force of many of the criticisms which have been directed against it.

The criticisms from which, however, it is least able to escape are those which call for lacking intermediate forms between tribes, families, and other great groups, or for some evidence that they ever existed. Here Prof. Phillips as a geologist feels his advantage and urges his point more aptly than some other critics have done.

"The explanation offered in the hypothesis of Mr. Darwin is, that the groups of life which appear to be and really are distinct, in the Cambro-Silurian rocks are not aboriginal forms, but derived from progenitors of far earlier date, belonging to few types or to one, the original form, and the transition forms being known to us. Now they are not unknown to us by any impossibility of being preserved, for the strata of the Cambro-Silurian series are of a kind in which organic remains of great delicacy are often preserved, and indeed such are preserved in these very strata; and by the hypothesis the life-structures which are lost must have only gradually differed in their nature from those which are preserved. It follows, therefore, that the earlier-living progenitors of the Cambro-Silurian series not only lived long before, but must have lived somewhere else. But as in all the known examples of this series of strata, wherever found, we have everywhere animals of the same general type, and nowhere the traces of the earlier progenitors, it is clear that everywhere we are required by the hypothesis to look somewhere else;—which may fairly be interpreted to signify that the hypothesis everywhere fails in the first and most important step. How is it conceivable that the second stage should be everywhere preserved, but the first nowhere?" (p. 214, 215.)

So, also, of what follows:

"Are we sure that varieties which are given by nature in successive generations can be *summed up in one direction* by the variable preponderant of a number of *concomitant variable conditions* of life? Can we remove 'natural selection' from the large synonomy of 'chance' except by giving to one of the variable conditions of which it is the sum, direction, definite value, or effect. Is it not the one acknowledged possession of every species, an inherent tendency to propagate its like? Would not the effect of this one constant among any number of variables without law be to preserve the characters of the species forever?" But what, we ask, is this inherent tendency of the species to propagate its like but the summing up in one direction of the tendency of each generation of individuals to propagate its like? Is not the occasional appearance of an offspring unlike the progenitor as much a natural fact as the contrary? And does not each initial variety, once originated, also have an inherent tendency to propagate its particular like, which, when it prevails for some generations, fixes a new "constant" which would equally tend "to preserve the characters of the 'variety' forever?"

"And," continues our author, "if 'natural selection' were regarded as giving direction to these variables, in combination with that constant tendency, what would be the final result but that which has always been recognized, viz: a species varying within limits which are to be sought out by experience. But finally, if natural selection be thus gifted with the power of continually acting for the good of its subject, encouraging it, or rather compelling it to continual advancement,—how is this beneficient personification to be separated from an ever-watchful providence,—

which once brought into view sheds a new light over the whole picture of causes and effects?" (p. 215, 216).

We answer, nohow, except by indicating to some extent the mode or way in which this Providence may operate.

The more we can recognize or clearly conceive the mode, the better; but, whether we can express the results of observation in the form of general laws or not, we are equally convinced that "what would be regarded as remarkable inventions if they were due to human minds and hands," "cannot be removed from the list of intelligent adaptations because they are frequent in nature, and are of higher perfection and greater beauty than any work of man;" and that "no one will ever be [or rather, reasonably can be] satisfied with laws which had no Author, works which had no Maker, co-ordinations which had no Designer."

And our author does simple justice to Lamarck in giving him the benefit of his own averment that "by Nature we are to understand a certain order of causes and effects constituted by the will of the Supreme Author of all things." The points against Darwin's theory made or suggested in the present volume, with so much acuteness, are all the more telling for the entire fairness and excellent spirit in which they are made. This is far more than can be said of the following essay, viz:

3. *Species not Transmutable nor the Result of Secondary Causes; being a Critical Examination of Mr. Darwin's Work*, &c; by C. R. Bree, Esq., M.D., F.L.S., &c.—London, Groombridge & Sons.—A favorable notice in the Athenæum of Dr. Bree's volume led us to suppose that it might be a contribution of some importance in the discussion of the nice questions which the publication of Mr. Darwin's book has raised. But this expectation has not been fulfilled on perusal. The author's intentions are praiseworthy, and his zeal in a good cause exuberant. But we cannot entertain a great respect for the reasoning of a writer who, on the one hand sees design and adaptation in the distribution of sunshine and rain, and the succession of the seasons, while on the other he insists that *because* "all the parts of a creature act harmoniously and co-ordinately one with another," necessitating the inference "that they were preordained to act collectively for the animal," therefore "they could not have been produced by [through] variation, natural selection, divergence of form," or indeed through any secondary causes whatever. We are unable exactly to comprehend how one who sees design and adaptation realized in the inorganic world through what are called secondary causes, is entitled to declare that the establishment of the doctrine of the succession of species,—each marked with more special if not stronger evidences of design than anything in inorganic nature,—through secondary causes, would "destroy every vestige of a shadow of belief in a watchful Providence and adaptive creation, and strike deeply and irrecoverably at the root both of natural and revealed religion." In our opinion such defenders of the faith play unwittingly into the hands of its most dangerous adversaries. A. G.

IV. BOOK NOTICES.

1. *The Manufacture of Vinegar: its Theory and Practice, with especial Reference to the Quick Process;* by CHARLES M. WETHERILL, Ph.D., M.D. Philadelphia, Lindsay and Blakiston, 1860. 12mo, pp. 300.—This is a very full, correct, and much needed treatise on an important branch of technology, and the book does credit both to the author and to the publishers. It is well printed and contains but few typographical errors, among which we remark "Bertholet" for "Berthelot," on p. 17, and "Reaumer" in all cases for "Reaumur."

The author professes to have based his work on Otto's "Lehrbuch der Essig Fabrikation," and says in the preface, "The general division of the work, many of the tables, all of the wood cuts, except two, and the quantitative analysis of vinegar, are borrowed from Otto." The first division of the book is devoted to an explanation of the general principles of chemistry, with especial reference to the subject in hand,—to an account of the nature, properties and transformations, of sugar and alcohol, and to a discussion of the various methods of determining the strength of alcoholic liquors and vinegars. The second part gives the practical details of the vinegar manufacture. Scientific accuracy is maintained throughout, and to the trained chemist the book is valuable as giving in one volume all the important matters relating to these various subjects. But though the general principles are clearly stated, it seems doubtful whether a mere practical man could fully comprehend all that is laid down. Yet he could understand enough to prevent him from becoming the dupe of men who make a great secret of the vinegar business and pretend to an exclusive knowledge of valuable receipts or methods. At the present time when scientific schools in various parts of our country, bring instruction within the reach of all who desire it, no one should engage as manager in the manufacture of vinegar, or in any other chemical manufacture, without previous study of chemistry and some training in chemical manipulation. One may learn a great deal from books, if he first learns how to understand books. One may derive much benefit from experienced workmen, if he first acquires a knowledge of natural laws and principles so that he can exercise a just control over the whims and prejudices which such workmen always possess. Like men of other trades, the vinegar maker too often insists on trifling points for which no better reason can be rendered than that such has been his beaten track; to such the work now under consideration will prove very useful, as it gives many actual variations in the practical details, thus showing that there are more ways than one of arriving at the same end.

One or two incidental matters occur in the book, to which we must be allowed to take exception. Wood vinegar is spoken of as "pyroxilic acid," and *pyroxylic*,—which is of pure Greek origin,—perhaps it ought to have been called; but the mongrel word *pyroligneous* has been so long exclusively in use that it should pass as the established name. The author also substitutes the term "raisin sugar" for *glucose*, because "*glucose* means *sweet*, and raisin sugar is inferior in sweetness to either

cane or fruit sugar." It would have been well to consider that *glucose* is derived from the positive γλυκός, and not from the superlative γλύκιστος; and nobody ever thought of calling metamorphosed starch *glucistose*, as the sweetest thing known. The transformations of starch, by the way, recall an undue extension given on p. 66,—and indeed very commonly in books,—to the name "British gum." Practical men—or at least many of them—distinguish roasted wheat starch as *British gum*, while roasted potato starch is called *gum substitute*. And the distinction is said to be founded on a real difference as great as that between the starches themselves.

In speaking of the expression "proof spirits" the author says, "the vinegar maker should be entirely ignorant of proof." But as long as spirits are bought and sold according to 'proof,' neither the buyer nor the seller should be ignorant of what the term means. The common material used in this country for making vinegar by the quick process, is whiskey. The consumer buys it at a specified price for the quantity of *proof spirit* that it contains. He buys say 1000 gallons of rectified whiskey at 25 cts. per gallon, and how much must he pay for it? It is invoiced perhaps as "40 over proof," that is, the 1000 gallons are actually equal to 1400 gallons of *proof spirit;* so the bill amounts to $350. To see whether this charge is correct he should test the liquor by the alcoömeter. One per cent of "dry" (absolute) alcohol is equal to two per cent of proof spirit—that is, New York proof. Hence if the article examined stands at 70° Tralles, it contains 140 per cent of proof spirit, or in commercial language is 40 over proof. So the vinegar maker can no more afford to be "ignorant of proof" than he can ignore the meaning of the term *gallon*.

The subject of acetometry is pretty fully discussed, and by the methods given, one accustomed to nice chemical manipulation will find no difficulty in determining the strength of vinegar. But it is desirable that the common workman should have some simple mode for testing the generators from day to day to see that they turn out a uniform product. There is such a plan in use among calico printers,—a plan which dispenses with exact weighings and measurings and nicely adjusted alcaline liquids, and is therefore deserving of especial mention in any work intended for practical men. Dry slacked lime is added to some of the vinegar to be tested, until there is an excess of lime present, which is known by a sudden change in the color of the solution to yellow or brown and the precipitation of some flocculent matter. The resulting liquid is allowed to settle and is at the same time cooled to 60° F. The hydrometer strength of the clear solution is now noted, and by reference to a table constructed for the particular hydrometer used, the strength in acetic acid will be found with accuracy, enough for all common purposes. Of course this method is applicable only to pure vinegars made from diluted alcohol. Whiskey vinegar is now very largely consumed in calico printing, and for this use it is commonly required to contain five per cent of dry acetic acid. The acetate of lime made from a vinegar of this strength stands at 8° of Twaddle's hydrometer.

The second part of the work describes several different arrangements of the apparatus for making vinegar as well as various modes of working; and one about to start or remodel a manufactory, would derive much advantage from a careful study of the many plans here detailed. Yet some questions might be asked to which the book gives no satisfactory answer. The first point to be decided is, of what size shall the graduators be made? They commonly have an average diameter of about 3½ feet and a height not exceeding 12 feet. But they seem to be so made rather from precedent than from any actual necessity. It is quite likely that there would be some advantage in having them much wider. As for height, we have no published accounts of any generators higher than 13 feet; and of course the greater the height, the greater is the difficulty of maintaining a sufficient circulation of air through the filling of shavings. Private experience however has shown that twice the ordinary height is none too great. For there are in this country generators in successful operation having a full height of 22 feet. The liquor to be acetified is raised, once for all, and passed through the 20 feet of filling, drawn out at bottom as finished vinegar. These long graduators produce quite as much strong vinegar for the same amount of filling as those of half the height worked in pairs; and being furnished with the feeding apparatus to be described presently, they dispense with a large part of the labor and attention required in the older ways of working.

As to the form of the generators, a word may be said. They are made somewhat conical so that the hoops may be driven tight; but which end should be uppermost? Graduators are always described and depicted as standing on the smaller end. Yet we cannot think of a single advantage in having them so set. It is true the filling usually shrinks more or less in the course of time, and one might suppose that were the taper from the bottom upwards, the filling would draw away from the sides and leave there too free a passage for the air. But it is a somewhat yielding mass we have to deal with. Therefore while it is shortened vertically it presses out laterally. There are on the other hand some slight reasons for departing from the usual custom and adopting the more stable position. The liquor to be acetified is likely to be more uniformly distributed in its passage downwards, if it is showered on the smaller end of a right conical column than when it falls on the larger base of an inverted frustrum. Again the liability to lateral leakage would be much lessened. In the third place some of the hoops require to be renewed while the generators are in operation, and it is easy enough at any time to slip a hoop over a smaller top and drive it down, but to get one up from below is by no means easy. It is particularly difficult to replace the bottom hoop when this has the least diameter of all.

There is much difference of opinion and practice with reference to the admission of air. Some "practical" men insist on boring the holes three or four feet above the false bottom. Others make them an inch or two above. Some lay great stress on bringing in the air by one or more wooden tubes passing up through the bottom of the generator and terminating just below the false bottom on which the filling rests. They forget that air is an elastic fluid and tends to diffuse itself equally

in every direction so that if it only has a chance to enter anyhow or anywhere below the filling, there is no danger of a partial distribution. There can be no simpler or better plan than to bore two or three holes in the sides just below the sieve bottom. If they are above, there is a chance for the filling to press against the inner orifices and hinder the ingress of air; and to go very high up, is to lose the benefit of all the filling below the holes.

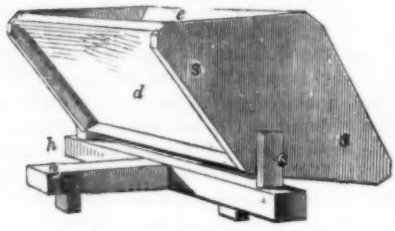
While speaking of air it may not be amiss to mention a very natural mathematical oversight that occurs in Dr. Wetherill's book on p. 259. It is said that:—"Otto discovered by numerous experiments that the air leaving generators in good action, contained from 14 to 16 per cent of oxygen, equivalent to from 4·9 to 6·9 per cent of the oxygen of the air employed in the vinegar fermentation." As in atmospheric air there is 20·9 oxygen to 79·1 nitrogen, an atmosphere that contains 16 per cent of oxygen or 84 per cent of nitrogen, must have had originally with this 84 of nitrogen $\frac{20{\cdot}9}{79{\cdot}1}\times 84 = 22{\cdot}2$ of oxygen. Hence it has lost $\frac{22{\cdot}2-16}{84+22{\cdot}2}$ $=5{\cdot}84$ per cent of the air itself or 27·8 p. c. of its oxygen. And so when an air contains 14 p. c. of oxygen, it has lost 8 p. c. of its first weight or 38·4 p. c. of its oxygen.

It is said that some manufacturers allow the vinegar to flow out at bottom as fasts as it trickles down, yet we nowhere find a sufficient reason rendered for this plan. Our author after describing a goose neck arrangement, as well as a peculiar cock for drawing the vinegar always from the very bottom of what is constantly accumulating, goes on to say:—"Besides the advantage of saving heat, the vinegar drawn from the bottom of the tub, as by the action of the goose neck or faucet, is of stronger quality, for several reasons which will be given in the proper place." This "proper place," however, is not to be found in the book, and a statement so very questionable is left unsupported by any reasoning. If there are any real advantages in the goose neck or any similar contrivance, it is desirable that they should be specified; for one who has never used such arrangements, can hardly conceive how anything can be, on the whole, better than periodical drawings from a common cock.

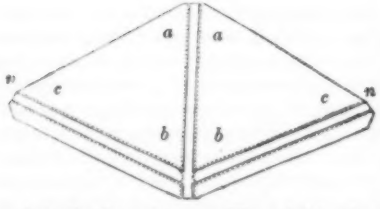
The filling is commonly looked upon as merely presenting an extended surface over which the liquor to be acetified flows in a tortuous course from top to bottom. But perhaps the graduator ought rather to be considered as a kind of apparatus for "displacement." It is not improbable that the alcoholic mixtures instead of simply trickling over the shavings saturated with vinegar, partly drives this absorbed vinegar before it, and so a part of the fresh mixture may be several days in reaching the bottom. In fact if we fill a generator with shavings soaked in water and then run on strong vinegar at a moderate rate, we find that it is some time before anything but water flows out from the bottom. This idea of displacement, if correct, ought to be taken into account in theorizing about the process, and it has also some practical bearings. Among other things it should enter into the discussion of the comparative advantages of a constant and a periodical running of the alcoholic mixture. In the case of an interrupted flow, the pores of the filling

have a chance each time to empty themselves partially of liquid and become filled with air; and the air will thus be brought into more intimate contact with the liquor of the next pouring. While with a constant flow, the air will be present only in the interstices and not in the pores. Our author very justly considers that pouring at intervals would be preferable to the constant flow, if it could be effected without the great amount of care and manual labor which it commonly requires. He probably is not aware that there has been used in some manufactories in this country, a very simple automatic pouring arrangement which leaves hardly anything to be desired. The principle is that of the oscillator in Gay Lussac's sulphuric acid apparatus. A barrel supported above the graduator, is furnished with a wooden cock which delivers the alcoholic mixture in a very slender stream into a vessel so poised that it shall tip and discharge its contents whenever it has received as much liquor as suffices to cover completely, for a moment, the distributing sieve head. The apparatus used by some consists of a single vessel which rights itself as soon as it has poured out its charge. But as this is made partly of sheet copper, it is liable to obvious objections. The writer has had in operation for more than a year, double oscillators made entirely of wood dove-tailed together. They are easy to construct and very satisfactory in their performance. Each of the compartments holds a wine gallon, which is amply sufficient to cover a sieve head 30 inches in diameter. Fig. 1 is a perspective view of the oscillator mounted on its frame. Fig. 2 shows the inside of the end piece with the dove-tail grooves, *n*, *n*. The whole of the oscillator itself is made of pine boards five-eighths of an inch thick. In the triangles *a b c*, the side *a c* is $7\frac{1}{2}$ inches long, *a b* is 6 inches and *b c* is 7 inches. The sides of the box *d* are $13\frac{1}{2}$ inches long, not including the dove-tail tongues. The middle piece *e* has a shallow, round, or angular groove on each side to receive the lower edges of the side pieces *d*. These side pieces are held fast by the pins *S*, *S*. An indentation on the outside of each end piece receives the sharp point of a brass or iron screw *G*, and on these points the box turns. The right place of the axis is determined by actual trials of the box temporarily poised at different points along the shorter diagonals of the end pieces. After the oscillator is permanently mounted, the tipping may be still farther adjusted by varying the height of the cushions *h* on which the sides *d* drop. The whole apparatus should be well painted before it is set on a sieve head. J. M. O.

1.



2.



2. *Chambers' Encyclopædia: a Dictionary of Universal Knowledge for the people.* Illustrated with maps and numerous engravings. Large 8vo. Vols. I and II. J. B. Lippincott & Co., Philadelphia. W. & R. CHAMBERS, Edinburgh. 1860.—This excellent Encyclopedia is on the basis of the German *Conversations Lexicon.* It is to be completed in six or seven volumes of about 800 pages each, and fully illustrated with woodcuts in the text and colored maps on steel. Its scientific articles are varied and generally able, covering natural history, physics, astronomy, topography, geography and medicine. The maps are models of clearness and elegance in that style of illustration, which they understand so well in Edinburgh. Messrs. Chambers have earned a well deserved reputation for their efforts to open the treasuries of human knowledge to the people, and in this new enterprize we see the culmination of all former efforts. It will, by the terms of its prospectus, be the cheapest general encyclopedia ever published, as well as one of the most comprehensive. It contains, as is just, few lengthy treatises such as we seek in the Encyclopedia Brittanica and in the American Cyclopedia, thus conforming more strictly to the original idea of an encyclopedia, which was first realized in English by EPHRAIM CHAMBERS in his Universal Dictionary of Knowledge (1728), the basis after the 6th edition, (in 1750) of Dr. Ree's Cyclopedia. We cordially commend the new Chambers' Encyclopedia as worthy of a place in every collection of books for reference.

3. *New American Cyclopedia.* Appletons, N. Y. 1861.—This able and useful work has reached its 11th volume, ending with the word 'Moxa.' It is the plan to close it with the 16th volume. Among the noticeable scientific articles in the 11th volume are '*Microscope*' and '*Mineralogy*,' the first due, as we infer, to Dr. Reuben, and the last to Mr. Hodge, both authors of numerous scientific articles of merit in this Cyclopedia. It is to be regretted that a work in general so excellent should not include in its plan of publication those simple illustrations without which it is hardly possible to make intelligible certain subjects, especially in physics and natural history. During the hours devoted to looking through these volumes, lingering with satisfaction to read not a few of their instructive articles, we have been much impressed with the great amount of discriminating labor and knowledge involved in the management of so great a variety of subjects.

4. *Second Report of a Geological Reconnoissance of the Middle and Southern Counties of Arkansas, made during the years* 1859 *and* 1860, by D. D. OWEN, Principal Geologist, assisted by ROBERT PETER, Chemical Assistant, LEO LESQUEREUX, Botanist, and EDWARD COX, Assistant Geologist. Philadelphia: C. Sherman & Son, Printers. 1860. 8vo, pp. 433.—Having already devoted p. 431–435 to an extended notice of the botanical portion of this Report, we can only add here its title in full. It is beautifully printed, and will be regarded with interest as the last labor of the lamented Owen. The Chemical Report by Dr. Peter contains the results of the analyses of one hundred and eighty-seven soils, subsoils, and underclays, and two nitre earths, besides a variety of other chemical work. The volume is concluded by a brief report by Assistant COX.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Catalogue of the Meteoric Collection of* CHARLES UPHAM SHEPARD, deposited in the Cabinet of Amherst College, Mass.

METEORIC STONES.

1. 1492, Nov. 7, *Ensisheim*, Alsace, Dép. du Haut-Rhin, France.
2. 1753, July 3, *Tabor* (Plan, Strkow), Bohemia.
3. 1753, Sept. 7, *Liponas*, Dép. de L'Ain, France.
4. 1768, Sept. 13, *Lucé* en Maine, Dép. de la Sarthe, France.
5. 1768, Nov. 20, *Mauerkirchen*, Inn, Lower Austria.
6. 1790, July 24, *Barbotan*, (Roquefort, Créon, Juillac, Mezin, Agen, &c.), Dép. des Landes, Dép. du Gers, Dép. du Lot et Garonne, formerly Gascony, France.
7. 1794, June 16, *Siena*, Tuscany.
8. 1795, Dec. 13, *Wold Cottage*, Yorkshire, England.
9. 1798, March 8–12, *Salès* near Villefranche, Dép. du Rhône, France.
10. 1798, Dec. 13, *Benares* (Krakhut village), Bengal, E. Indies.
11. 1803, April 26, *L'Aigle*, Normandy, Dép. de l'Orne, France.
12. 1803, Oct. 8, *Apt* (Saurette), Dép. de Vaucluse, France.
13. 1805, March 25, *Doroninsk*, Government Irkutsk, Siberia.
14. 1806, March 15, *Alais*, St. Étienne de Solm and Valence, Dép. du Gard, France.
15. 1807, March 13, *Timochin*, Juchnow, Smolensk, Russia.
16. 1807, Dec. 14, *Weston*, Connecticut, U. S. A.
17. 1808, April 19, *Parma* (Casignano, Borgo St. Domino), Italy.
18. 1808, May 22, *Stannern*, Iglau, Moravia.
19. 1808, Sept. 3, *Lissa*, Bunzlau, Bohemia.
20. 1810, Aug. *Tipperary* (Mooresfort), Ireland.
21. 1810, Nov. 22, *Charsonville* near Orleans, Dép. du Loiret, France.
22. 1811, March 12, *Kuleschowka*, Gov. Poltawa, Russia.
23. 1811, July 8, *Berlanguillás*, near Burgos, Upper Castilia, Spain.
24. 1812, April 15, *Erxleben*, between Madgeburg and Helmstaedt, Prussia.
25. 1812, Aug. 5, *Chantonnay*, between Nantes and La Rochelle, Dép. de la Vendée, France.
26. 1813, Sept. 10, *Limerick* (Adare, Scagh, Brasky, Faha), Limerick county, Ireland.
27. 1814, Feb. 3, *Bachmut* (Gov. Iekaterinoslaw), Russia.
28. 1814, Sept. 5, *Agen*, Dép. du Lot and Garonne, France.
29. 1815, Oct. 3, *Chassigny*, near Langres, Dép. de la Haute-Marne, France.
30. 1818, April 10, *Zaborzika* (Saboryzy, Saboritz on the Slutsch,) Volhynia, Russia.
31. 1818, June, *Seres*, Macedonia, Turkey.
32. 1818, Aug. 10, *Slobodka*, Iuchnow, Gov. Smolensk, Russia.
33. 1819, June 13, *Jonzac* (Barbezieux), Dép. de la Charente, France.
34. 1819, Oct. 13, *Politz*, near Gera, Dutchy of Reuss.
35. 1820, July 12, *Lixna* (Liksen), Lasdany, Gov. Witepsk, Russia.
36. 1821, June 15, *Juvenas*, near Libornez, Dép. de l'Ardèche, France.

37. 1822, Nov. 30, *Futtehpore*, near Allahabad, Hindostan, E. Indies.
38. 1823, Aug. 7, *Nobleborough*, Maine, U. S. A.
39. 1824, Jan. 15, *Renazzo*, Ferrara, Papal States.
40. 1824, Oct. 14, *Zebrak* (Praskoles), near Horzowitz, Beraun, Bohemia.
41. 1825, Government *Iekaterinosław*, Russia.
42. 1825, Feb. 10, *Nanjemoy*, Maryland, U. S. A.
43. 1825, Sept. 14, *Honolulu* (Owyhee, Hawaii), Sandwich Islands.
44. 1826 or 1827, *Waterloo*, New York, U. S. A.
45. 1827, May 9, *Nashville*, Tennessee, U. S. A.
46. 1827, Oct. 5, *Bialystok* (Kuasta, or Kuasti village), Russian Poland.
47. 1828, June 4, *Richmond*, Virginia, U. S. A.
48. 1829, May 8, *Forsyth*, Georgia, U. S. A.
49. 1829, Aug. 15, *Deal*, near Long Branch, New Jersey, U. S. A.
50. 1831, Sept. 9, *Wessely* (Dorf Znorow), Moravia.
51. 1833, Nov. 25, *Blansko*, Bruenn, Moravia.
52. 1834, June 12, *Charwallas*, near Hissar, E. Indies.
53. 1836, Nov. 11, *Macao*, Prov. Rio Grande de Norte, Brazil.
54. 1837, Aug. *Esnaude*, Dép. de la Charente, France.
55. 1838, June 6, *Chandakapore*, Berar, E. Indies.
56. 1838, Oct. 13, *Capeland* (Cold Bokkewelde), Cape of Good Hope, Africa.
57. 1839, Feb. 13, *Little Piney*, Pulaski County, Missouri, U. S. A.
58. 1840, July 17, *Cereseto*, near Offiglia, Casale, Piedmont.
59. 1840, *Concord*, New Hampshire, U. S. A.
60. 1841, March 22, *Grüneberg* (Heinrichsau), Prussian Silesia.
61. 1841, June 12, *Château-Renard*, Dép. du Loiret, France.
62. 1842, April 26, *Milena* (Milyan), Pusinsko Selo, Croatia.
63. 1842, June 4, *Aumières*, Canton St. George, France.
64. 1843, March 25, *Bishopsville*, South Carolina, U. S. A.
65. 1843, June 2, *Utrecht*, Blaauw Kapel, Loewenhutye, Netherlands.
66. 1843, Sept. 16, *Klein-Wenden*, near Nordhausen, Prussia.
67. 1844, April 29, *Killeter*, County of Tyrone, Ireland.
68. 1844, Oct. 21, *Favars*, Canton de Laissac, France.
69. 1846 or 1847, *Richland* (near Columbia), So. Carolina, U. S. A.
70. 1846, May 8, *Macerata*, Monte Milan village, Ancona, Papal States.
71. 1847, Feb. 25, *Linn county*, Iowa, U. S. A.
72. 1848, May 20, *Castine*, Maine, U. S. A.
73. 1849, Oct. 31, *Cabarras county*, North Carolina, U. S. A.
74. 1850, Nov. 30, *Shalka* (Sulker, near Bissempur), Bancoora, India.
75. 1851, April 17, *Guetersloh*, Westphalia.
76. 1852, Sept, 4, *Mezö-Maduras* (and Fekete), Transylvania.
77. 1853, March 6, *Segowlee* (Soojoulee), India.
78. 1853, Feb. 10, *Girgenti*, Sicily.
79. 1854, Found. *Pegu*.
80. 1855, May 13, *Bremervoerde*, Landdrostei-Stade, Hanover.
81. 1855, Aug. 5, *Petersburg*, Lincoln county, Tennessee, U. S. A.

82. 1857, Oct. 10, *Ohaba*, East of Karisburg, Transylvania.
83. 1857, Feb. 27, *Parnallee*, S. Hindostan.
84. 1858, May 19, *Kakova*, Northwest of Oravitza, Temesvar, Banat.
85. 1858, Dec. 9, *Ausson*, (Montrejean), France.
86. 1859, March 26, *Harrison county*, Kentucky, U. S. A.
87. 1859, Aug. 11, *Bethlehem*, near Albany, New York, U. S. A.
88. 1860, May 1, *New Concord*, Muskingum county, Ohio, U. S. A.

Meteoric Irons.

Dates of Discovery or of Fall.			
1.	Fell	1751, May 26,	*Agram* (Hraschina village), Croatia.
2.	Discov.	1751,	*Steinbach*, between Eibenstock and Joharn-Georgenstadt, Saxony.
3.	"	1768,	*Senegal*, Siratik in Bambuk, Africa.
4.	"	1776,	*Krasnojarsk*, Gov. Jeneseisk, Siberia.
5.	"	1784,	*Toluca*, (Xiquipilco), Mexico.
6.	"	1788,	*Tecuman* (Otumpa), Argentine Republic, S. America.
7.	"	1792,	*Zacatecas*, Mexico.
8.	"	1801.	*Cape of Good Hope*, Africa.
9.	"	1811,	*Elbogen*, Bohemia.
10.	"	1811,	*Durango*, Mexico.
11.	"	1814,	*Bitburg*, Lower Rhine, Prussia.
12.	"	1814,	*Texas* (Red River), U. S. A.
13.	"	1815,	*Lenarto*, Scharosch, Hungary.
14.	"	1816,	*Bahia* (Bemdego), Brazil.
15.	"	1818,	*Lockport*, New York, U. S. A.
16.	"	1819,	*Burlington*, Otsego County, New York, U. S. A.
17.	"	1820,	*Guildford*, North Carolina, U. S. A.
18.	"	1824,	*Rasgata*, New Grenada, S. America.
19.	"	1827,	*Atacama*, Bolivia.
20.	"	1828,	*Caille* (Grasse), Dép Du Var, France.
21.	"	1829,	*Bohumilitz* Prachin, Bohemia.
22.	"	1834,	*Claiborne County*, Alabama, U. S. A.
23.	Fell	1835, July 30,	*Dickson* county, Tennessee, U. S. A.
24.	Discov.	1835,	*Black Mountain*, Buncombe county, North Carolina, U. S. A.
25.	"	1839,	*Asheville*, Buncombe county, North Carolina, U. S. A.
26.	"	1839,	*Putnam* county, Georgia, U. S. A.
27.	"	1840,	*Cocke* county (Cosby-Creek, also Sevier county), Tennessee, U. S. A.
28.	"	1841,	*Newberry* (Ruff's Mountain), South Carolina, U. S. A.
29.	"	1842,	*Green* county (Babb's Mills), Tennessee, U. S. A.
30.	"	1843,	*Oaxca*, Mexico.
31.	Discov.	1843,	*St. Augustine's Bay*, Madagascar.
32.	"	1843,	*Arva* (Szlanicza), Hungary.

33. Discov. 1845, *Otsego* county, New York, U. S. A.
34. " 1845, *De Kalb* county, Tennessee, U. S. A.
35. " 1846, *Carthage*, Tennessee, U. S. A.
36. " 1847, *Chesterville*, Chester District, South Carolina, U. S. A.
37. Fell 1847, July 14, *Braunau*, (Hauptmannsdorf), Koeniggraetz, Bohemia.
38. Discov. 1847, *Seeläsgen*, Newmark, Brandenburg, Prussia.
39. " 1850, *Schwetz*, Province of Prussia.
40. " 1850, *Salt River*, Kentucky, U. S. A.
41. " 1850, *Pittsburg*, Pennsylvania, U. S. A.
42. " 1850, *Seneca Falls*, Cayuga county, New York, U. S. A.

Discovered.

43. 1850–1854, *Lion River*, Namaqua Land, South Africa.
44. " " *Union* county, Georgia, U. S. A.
45. " " *Tazewell*, Claiborne county, Tennesse, U. S. A.
46. " " *Santa Rosa*, New Mexico.
47. " " *Tuczon*, Sonora.
48. " " *Hemalga*, Talcahuaxo, Chili.
49. " " *Haywood* county, North Carolina, U. S. A.
50. " " *Oktibbeha* county, Mississippi.
51. " " *Orange River*, South Africa.
52. 1854, *Madoc*, Canada West.
53. 1856, *Hainholz*, S. W. of Paderborn, Minden, Westphalia.
54. " *Forsyth*, Taney county, Missouri, U. S. A.
55. " *Nebraska Territory*, (between Council Bluffs and Fort Union), on the Missouri River.
56. " *Campbell* county, Tennessee, U. S. A.
57. " *Nelson* county, Kentucky, U. S. A.
58. " *Jewell Hill*, Madison, co., North Carolina, U. S. A.
59. " *Marshall* county, Kentucky, U. S. A.
60. " *Brazos*, Texas, U. S. A.
61. " *Denton* county, Texas, U. S. A.
62. " *Oldham* county, near Lagrange, Kentucky, U. S. A.
63. " *Robertson* county, Tennessee, U. S. A.

Total—88 Stones and 63 Irons, or 151 Meteorites. Their aggregate weight is 820 pounds. The largest stone weighs 51 pounds, and the largest iron mass, 326. The collection contains a large problematical mass from Homony Creek, Buncombe county, North Carolina, supposed to be an altered meteoric iron; also numerous native iron and steel-like masses whose origin is not understood, but which are suspected to be meteoric. To this latter group belong the specimens from Achen, France; Collina de Brianza, Brazil; Walker county, Alabama; Scriba, New York; Randolph county, North Carolina; Bedford county, Pennsylvania; Montgomery, Vermont; Rutherford, North Carolina, and some others. The black capillary matter seen to fall in a glowing state at Charleston, South Carolina, on the evening of Nov. 16, 1857, is also preserved in this collection.

New Haven, Conn., Nov., 1860.

2. *Note and Correction to Mr. T. Sterry Hunt's paper on Types*, this vol. p. 256–264.—To follow the note on p. 261:—"The formation of a nitrite in the experiments of Cloez appears to be independent of the presence of ammonia, and to require only the elements of air and water (*Comptes Rendus*, lxi, 935). Some experiments now in progress lead me to conclude that the appearance of a nitrite in the various processes for ozone, is due to the power of nascent oxygen to destroy by oxydation the ammonia generated by the action of water on nitrogen, the nitrous nitryl; so that the odor and many of the reactions assigned to ozone or nascent oxygen are really due to the nitrous acid which is set free when nascent oxygen encounters nitrogen and moisture. On the other hand, nascent hydrogen, which readily reduces nitrates and nitrites to ammonia, by destroying the regenerated nitrite of the nitryl, produces ammonia in many cases from atmospheric nitrogen."

Two errors of the press occur in the first seven lines of p. 264—which are corrected in the following paragraph:

"Without counting the still more basic sulphates of zinc and copper, described by Kane and Schindler, we have the following salts, which in accordance with Wurtz's notation, correspond to the annexed radicals:

1. Unibasic, - - - - $S_2H\ O_7 = S_2O_5$ monatomic.
2. Bibasic, - - - - - $S_2H_2O_8 = S_2O_4$ diatomic.
3. Quadribasic, - - - - $S_2H_4O_{10} = S_2O_2$ tetratomic.
4. Sexbasic, - - - - - $S_2H_6O_{12} = S_2$ hexatomic.
5. Octobasic, - - - - $S_2H_8O_{14} = S_2 - O_2$ octatomic.

3. *Texas Survey.*—We have received the following note from W. M. Gabb on this subject, which we publish without comment.

"I take this opportunity of correcting a statement in your last issue of the Am. Jour. Sci. in regard to my friend Dr. Moore of the Texas Geological Survey. * * * Having been personally cognizant of all the circumstances connected with the change, I feel able to speak confidently of the matter.

"It was determined that when Dr. Shumard's term of appointment should expire (November, 1860) that he should be removed. There were two applicants for the post, and Dr. Moore obtained the use of certain 'influential names' for the purpose of counteracting the weight of a letter written by Humboldt some thirty years ago, in recommendation of the other applicant, and *not* to prejudice Dr. S., whose removal had *nothing* to do with the appointment of any particular successor.

"While I have every confidence in Dr. Shumard's ability as a geologist, I cannot believe that his successor is inferior to him either in erudition, skill or ability. I hope therefore that you will do justice to a gentleman who has been thus unfairly placed before the scientific public.

I remain your ob't serv't, W. M. Gabb."

Philadelphia, March 28, 1861.

4. *Kentucky Geological Reports.*—On page 294 we spoke of the fourth volume of the Kentucky Reports now in press as the 'concluding' volume. As the survey of Kentucky is far from being complete, it is to be hoped that new appropriations of money will enable Dr. Peter and his associates to go on with the work. The chemical part of the fourth volume, covering 390 pages and a vast amount of chemical labor, has just reached us, and will be noticed hereafter.

OBITUARY.

ERNEST HAEUSSER, an excellent geologist and mining engineer, died in New York on the 18th of February, aged about 35 years. A native of Saxony, educated by the government at the Mining Academy at Freiberg, he came to this country about eight years ago. He was engaged on the Geological Survey of New Jersey, chiefly in the examination of the northern counties of that State, from 1855 to the suspension of the survey. Some of the results of his labors (without his name) have appeared in the Annual Reports of that survey. Frequent exposure to the sickly climate of the Southern States when exploring in North Carolina and elsewhere, broke down his health, developing by intermittent fever the consumption which carried him off. Cautious, truthful, excellent in character, his decease is a great loss to mining enterprises, in which there is always need of the qualities which distinguished Ernest Haeusser.

Botanical Necrology for 1860.—*Professor Hochstetter* of Esslingen, Wirtemburg, died on the 19th of February, at the age of 74 years. The Rev. Prof. Hochstetter produced no important botanical works; but he and his associate Steudel, whom he survived two or three years, were active promoters of botany through the *Unio Itineraria*, an association for furthering botanical collections—of which they were the managers.

Professor J. G. C. Lehmann, of Hamburgh, who died on the 12th of February, in his 68th year, was a botanist of note, and a voluminous author. His earliest work, a monograph of *Primula*, appeared in 1817, his monograph of the *Asperifoliæ* the year after, that of *Potentilla* in 1820. He elaborated the *Onagraceæ* and his favorite genus *Potentilla* for Hooker's Flora of British America; and his latest publication of any magnitude and crowning work was his *Revisio Potentillarum*, a fine quarto volume with 64 plates, issued in the year 1856, an excellent monograph.

G. H. von Schubert, a Bavarian botanist of a former generation, to whom Mirbel in 1813, under the name of *Schubertia*, dedicated the genus established for our southern Cypress, which Richard had earlier called *Taxodium*—survived until July last, having attained the age of 80 years. He is commemorated in an Asclepiadeous genus from Brazil, established by his fellow-countrymen, Martius and Zuccarini.

Dr. J. F. Klotzsch, keeper of the Royal Herbarium at Berlin for the last twenty-five years, died on the 5th of November last at the age of 55 years. As a systematic botanist, Dr. Klotzsch worked industriously, observed discriminatingly, but generalized badly, or rather—like others of the same school—wanted that largeness of view which enables the able naturalist to discover, almost instinctively, the true characters and just subordination of natural groups, in the midst of the most diversified details, and that gift of sound judgment as to natural genera in which Linnæus and the other great masters so much excelled most even of the better botanists of the present age. Dr. Klotzsch's monograph of *Begoniaceæ*, and his papers on *Euphorbiæ* (one of the latter, which dismembers the Linnæan genus *Euphorbia* into more than a dozen genera, published during the past year,) are striking illustrations of the opposite system. The distinctions are doubtless for the most part true and good; their valuation is open to serious objection.

Louis de Vilmorin, of Paris, died on the 22d of March, 1860, at the age of 44 years. Although his name and that of his venerable, still-

surviving father (to whom DeCandolle dedicated the genus *Vilmorinia*,) hardly appears in the catalogue of botanical authors, yet both have rendered important service to botanical science, while contributing most essentially to the advancement of agriculture and horticulture by original observations, and by experimental researches, devised and conducted upon truly scientific principles, respecting the formation of varieties and their fixation into races, and the amelioration and augmentation of the useful products of cultivated plants. A notice of some of the brief but most suggestive papers of the Vilmorins upon this subject was given in the 27th volume (new series) of this Journal (May, 1829). In devising and conducting such experiments, often requiring both physiological and chemical knowledge, a delicate skill in manipulation, and a quick eye for natural affinities, the younger Vilmorin was unrivalled, and his death in the midst of so useful and so honorable a career, has left a serious void. It is but just to his memory to acknowledge that we have learned more from him respecting the laws and conditions which govern both the production and the preservation of vegetable varieties and races than from any other source. What with his characteristic modesty he entitled an *Essai d'un Catalogue Methodique et Synonymique des Froments*, arranging the sorts of Wheat known in cultivation under fifty-three sections, reduced to seven botanical species, is a work which required the researches of years, although only a pamphlet of fifty pages, and is his most extended publication. His several articles, since collected under the title of *Notice sur l'amélioration des plantes par le senis, et considérations sur l'heredité des vegetaux* are characteristically brief. But they are all the result of the most conscientious, skillful, and prolonged investigations, and all are real contributions to knowledge, the value of which is not to be estimated by the bulk of the record.

J. B. Payer, one of the botanical members of the Academy of Sciences, and Professor of Vegetable Organography and Anatomy of the Faculty of Sciences, at Paris, died on the 5th of September last, aged only 42 years. The correspondence of M. Nicklès has already supplied a biographical notice of Payer, in the preceding (March) number of this Journal. His speciality was organogeny; his principal work *Traité d'Organogénie Comparée de la Fleur*, in imperial octavo, with 154 crowded plates, is a very handsome and imposing production, but perhaps not of the highest critical value. His seat at the Academy of Sciences has recently been filled by another organogenist, of excellent promise, M. Duchartre.

John E. LeConte, former Major of U. S. Topographical Engineers,—whose death, at Philadelphia, in November last, aged 77, was announced in our March No., (p. 303)—was almost the Nestor of American botanists, although his principal contributions to science, except the earlier, relate to zoology, chiefly to entomology and herpetology. His first botanical publication, a Catalogue of the Plants growing spontaneously on the Island of New York, appeared just half a century ago. Many of the choicest botanical stations even seventeen years later, when Dr. Torrey issued his Catalogue of the same district, were as low as Canal St., and Peck's Slip. Even the earlier author lived to see nearly his whole florula extinguished, swept away by denudation, or unconformably overlaid by recent strata of stone, brick and mortar. Major LeConte made exten-

sive collections in Georgia at a period when that part of the country had been little explored, and freely imparted his materials and his valuable observations to working botanists. He also published several good botanical papers in the earlier volumes of the Annals of the Lyceum of Natural History, New York, and more recently, in the Proceedings of the Academy of Natural Sciences, Philadelphia, an Enumeration of the North American Vines, and a paper on the species of Tobacco, with which, unfortunately, we are not acquainted. For the last ten or twelve years Major LeConte has resided in Philadelphia; and we are to expect from one of his scientific associates there, a fitting tribute to the memory of this venerable, genial, and accomplished gentleman and naturalist.

A. G.

Death of Prof. J. W. Gibbs.—JOSIAH WILLARD GIBBS, LL.D., Professor of Sacred Literature in Yale College, died in New Haven, March 25, 1861, aged 70.

He was born in Salem, Mass., April 30, 1790, and graduated at Yale College in 1809. He was Tutor in this institution from 1811 to 1815, and Librarian from 1824 to 1843. From 1826 to the time of his death he was Professor of Sacred Literature in the Theological Department of the College, having been Lecturer here in 1824 and 1825. He was author of a valuable Hebrew Lexicon, and of an abridgment thereof, and of several minor works relating to grammatical and philological subjects, as well as of numerous contributions to the periodical works of his time. The earlier volumes of this Journal contain several important papers from his pen.

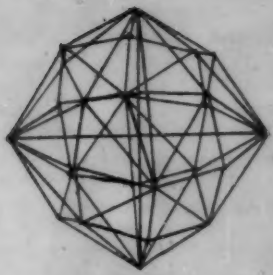
He was eminent for careful and thorough research, and all his productions bear marks of exact scholarship. He had been for several years an active member of the American Oriental Society, and of the Connecticut Academy of Arts and Sciences. The last named body, at their meeting of April 17, 1861, passed resolves expressive of their high estimate of the character of the deceased and lamenting his departure.

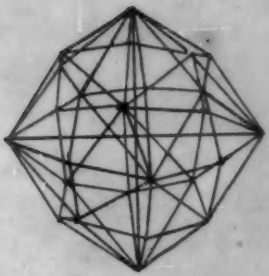
New Planets.—A new planet, of the 13th magnitude, was discovered April 9, 1861 by Mr. H. P. Tuttle, at the Observatory at Cambridge, Mass. It is probably the 66th of the asteroidal group, the 64th and 65th having been discovered at Marseilles, March 4 and 11, 1861.

New Comet.—A telescopic comet was discovered early in April, in *Draco*, by Mr. Thatcher, at the observatory of Mr. L. M. Rutherford in New York City.

NOTICE.—*The American Association for the Advancement of Science.*—The Standing Committee have announced that the meeting adjourned to Nashville for 17th April, 1861, will be postponed for one year, to be convened in Nashville, April 1862, unless otherwise ordered in the meantime.

Index photographed at the
beginning for the convenience
of the microfilm user.

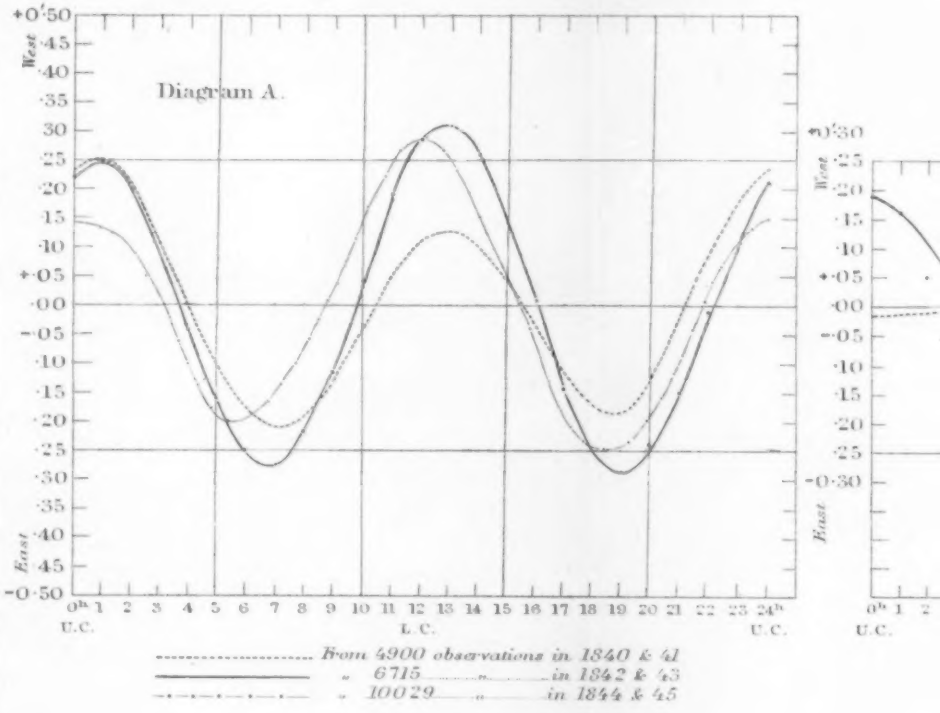




DISCUSSION OF THE MAGNETIC AND M

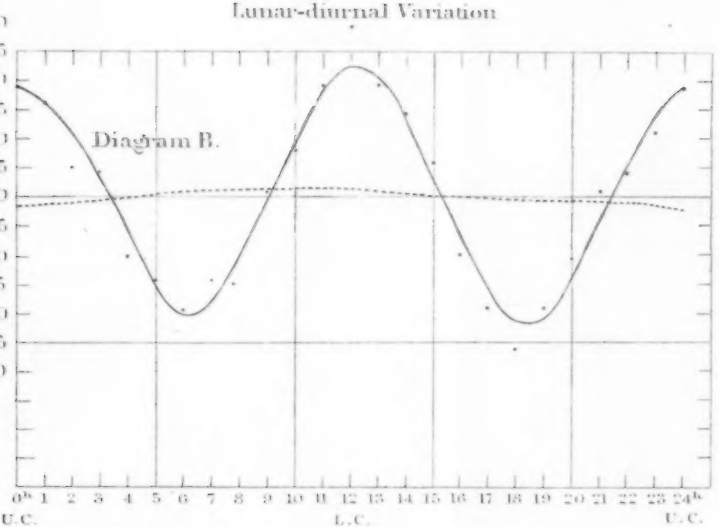
IN 1840, 41, 42, 43, 44, & 45

Lunar-diurnal Variation of the Magnetic Declination



Lunar-diurnal Variation

Diagram B.



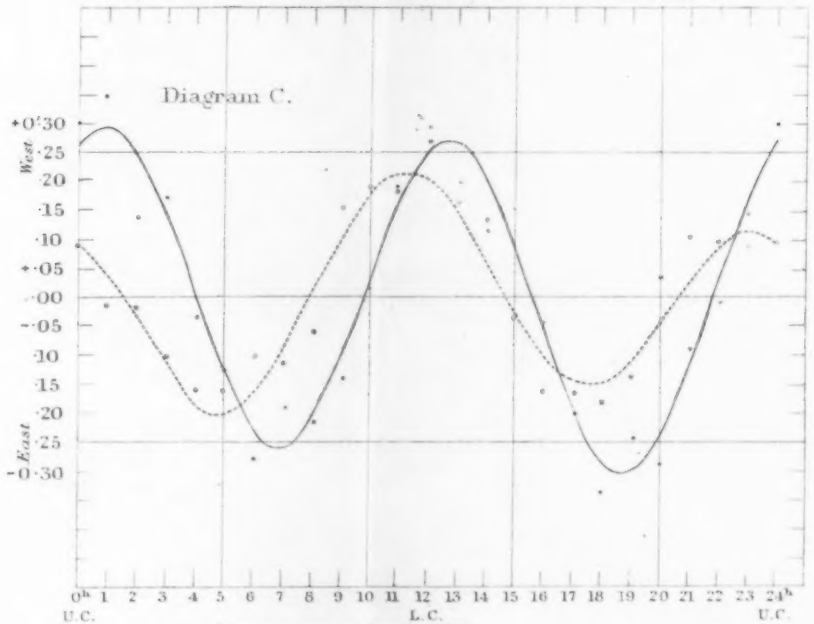
From 21644 observations at Philadelphia from 1840 to 1845

Lunar-diurnal Variation

In Summer ———

In Winter .....

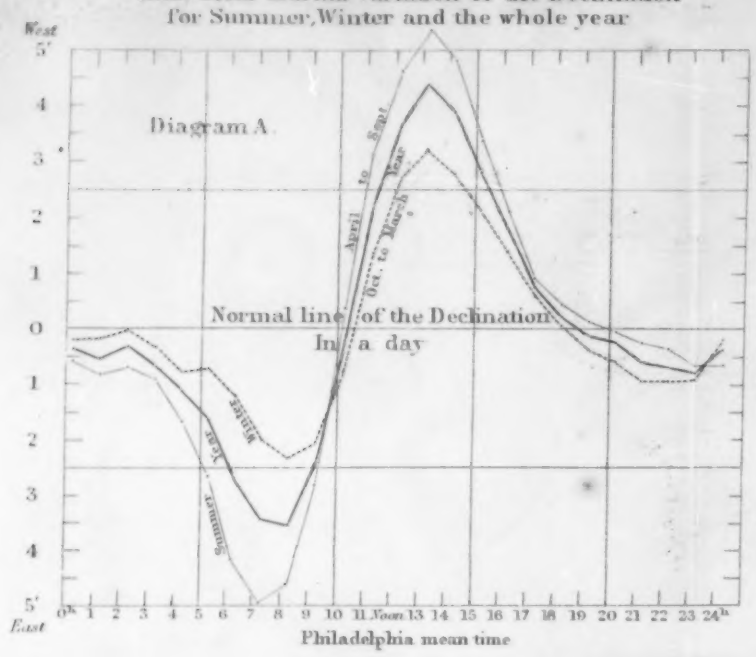
Diagram C.



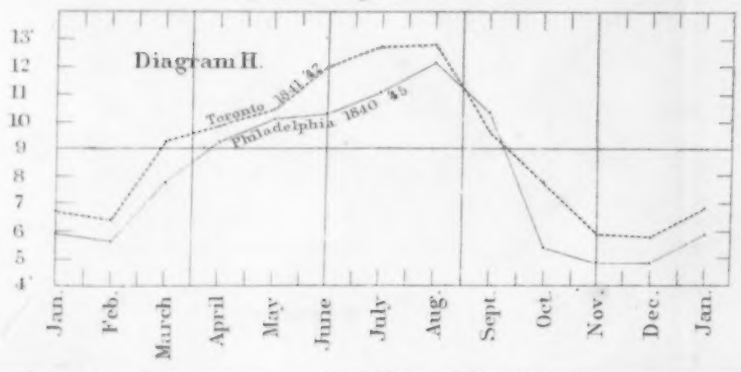
Summer curve from 11087 ..... (a)

Winter curve from 10557 ..... (b)

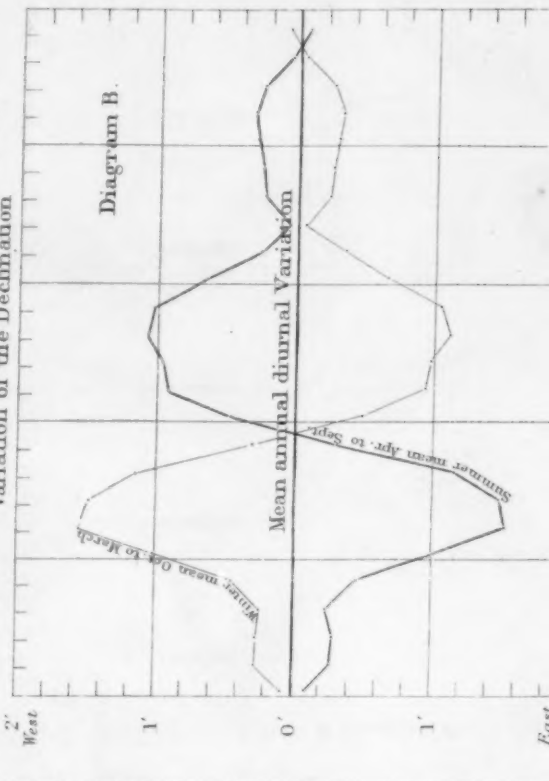
Mean Solar diurnal Variation of the Declination
For Summer, Winter and the whole year



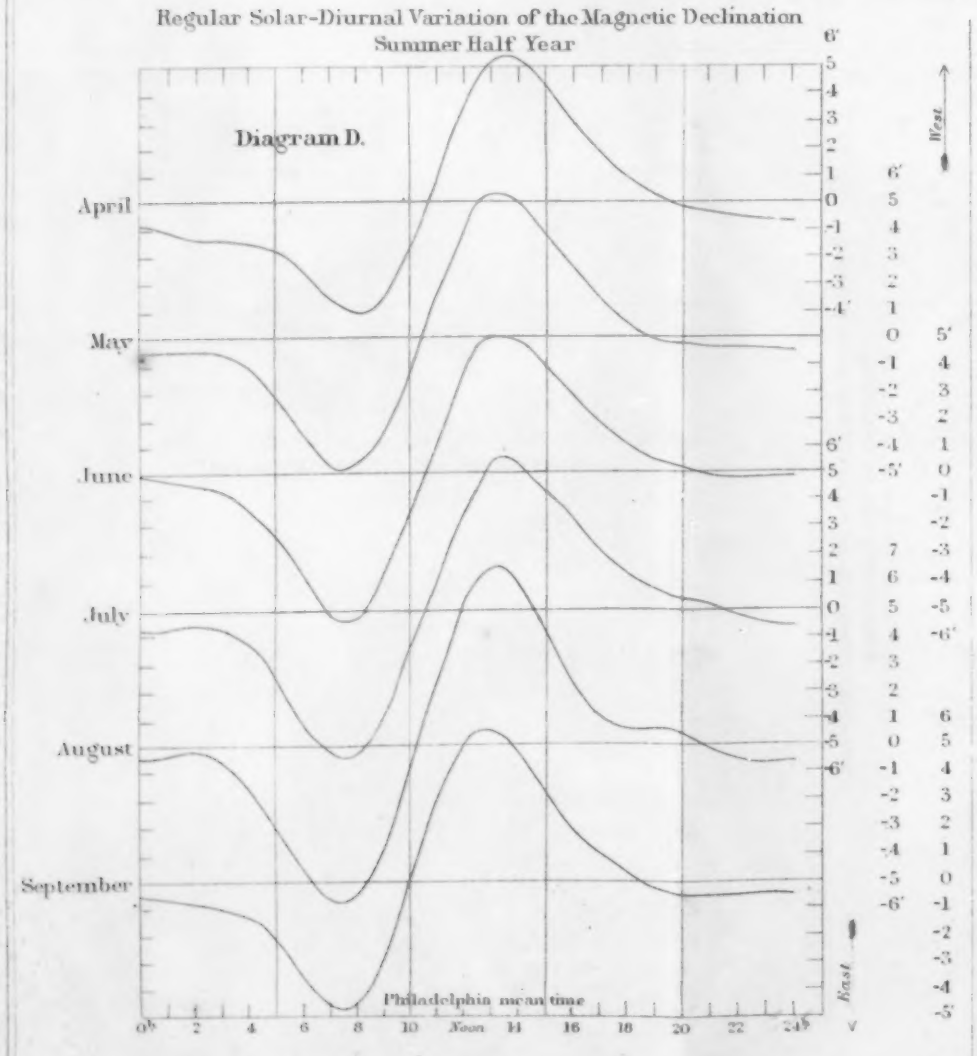
Diurnal range of the Declination



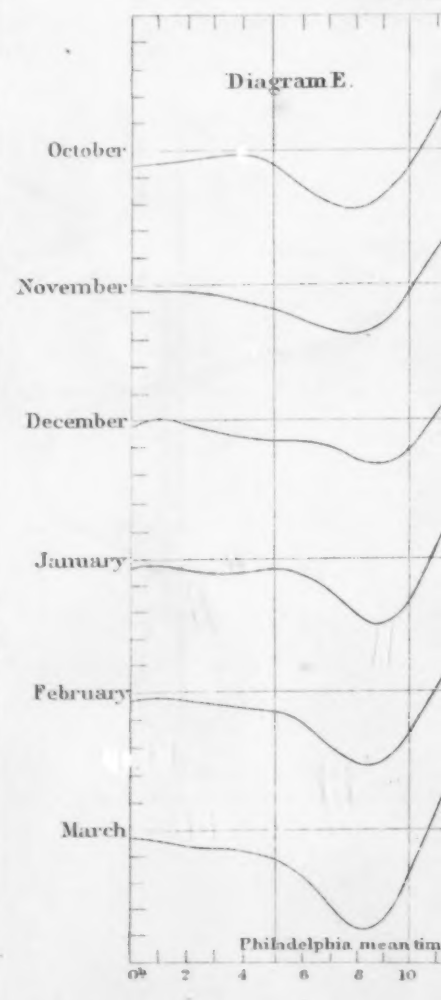
Semi-annual inequalities in the Solar-diurnal Variation of the Declination



Regular Solar-Diurnal Variation of the Magnetic Declination
Summer Half Year

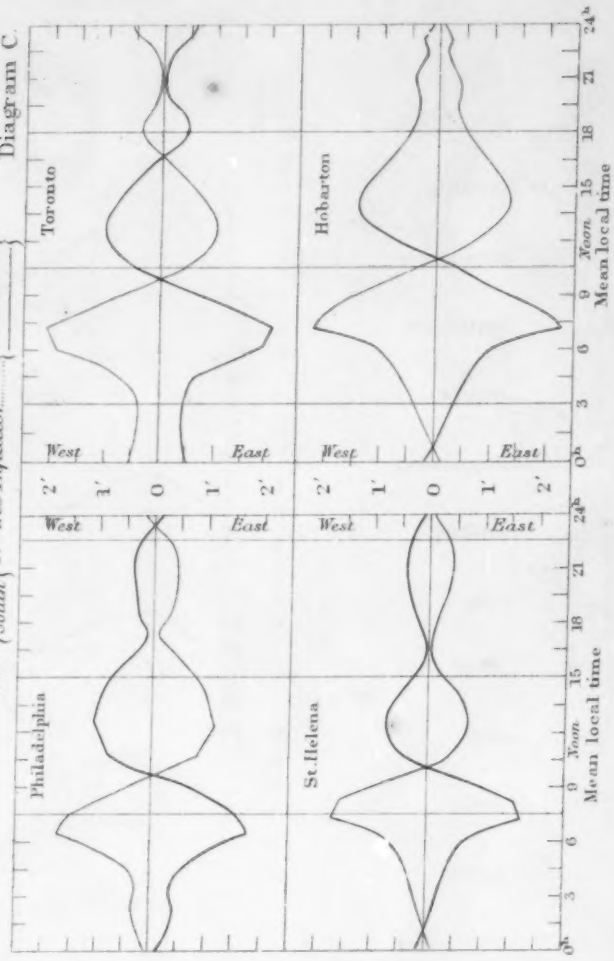


Regular Solar-Diurnal Vari
Winte



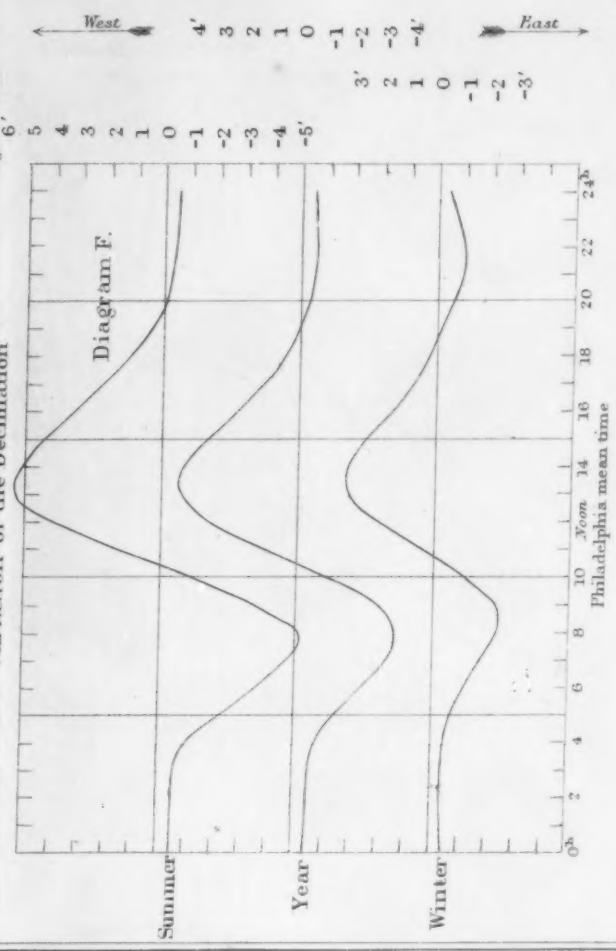
Comparative Diagram
of the semi-annual deflection of the Solar-diurnal Variation
Sun {North / South} *of the Equator*

Diagram C.



Type Curves of the regular-Solar diurnal Variation of the Declination

Diagram F.



rnal Variation of the Magnetic Declination
Winter Half Year

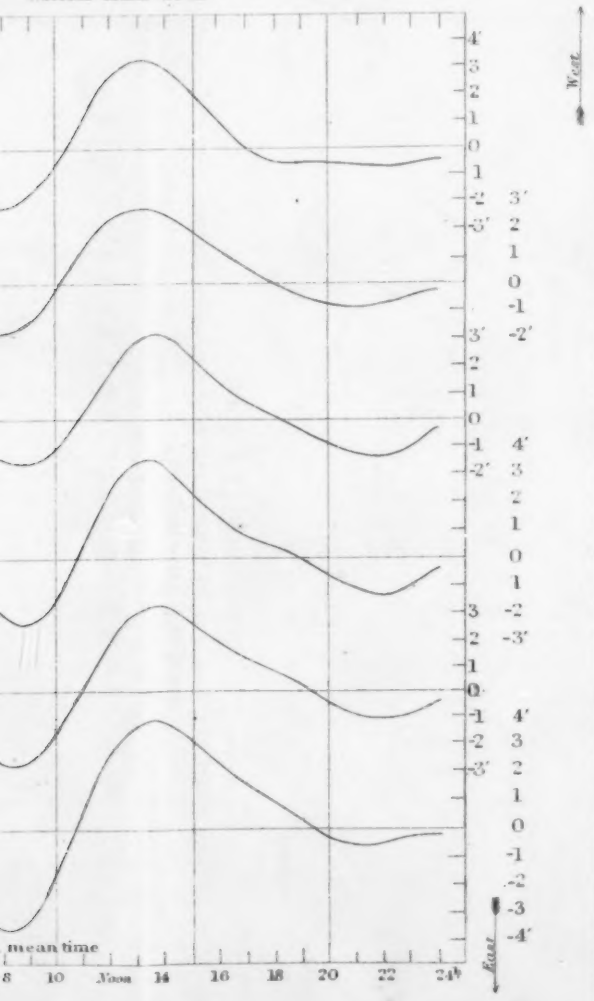
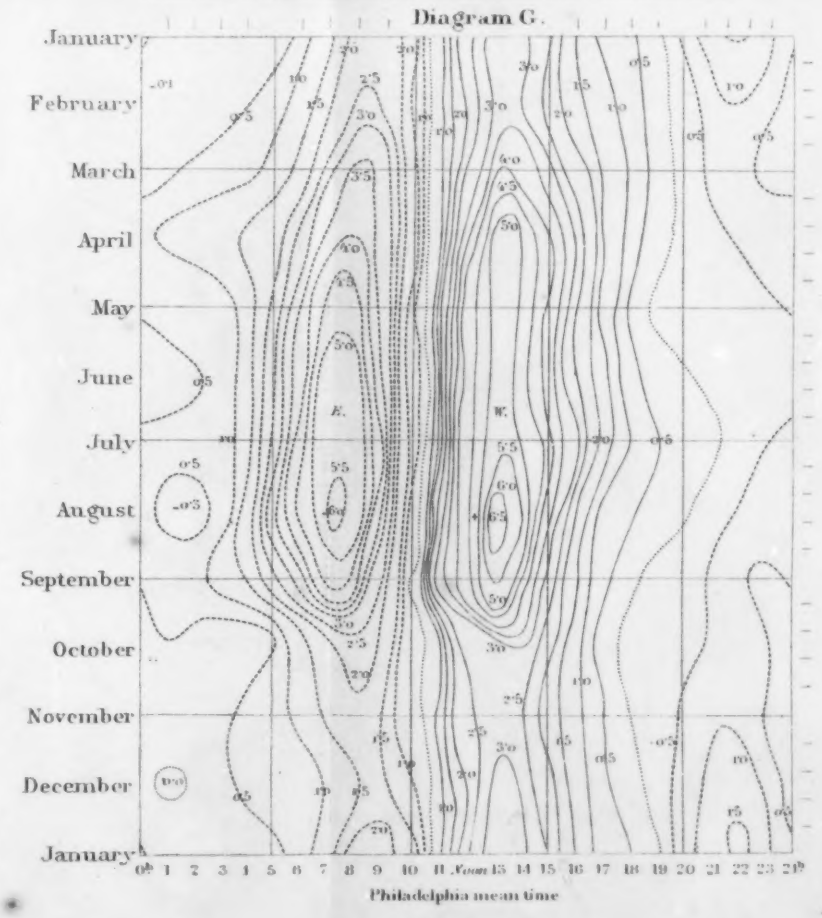
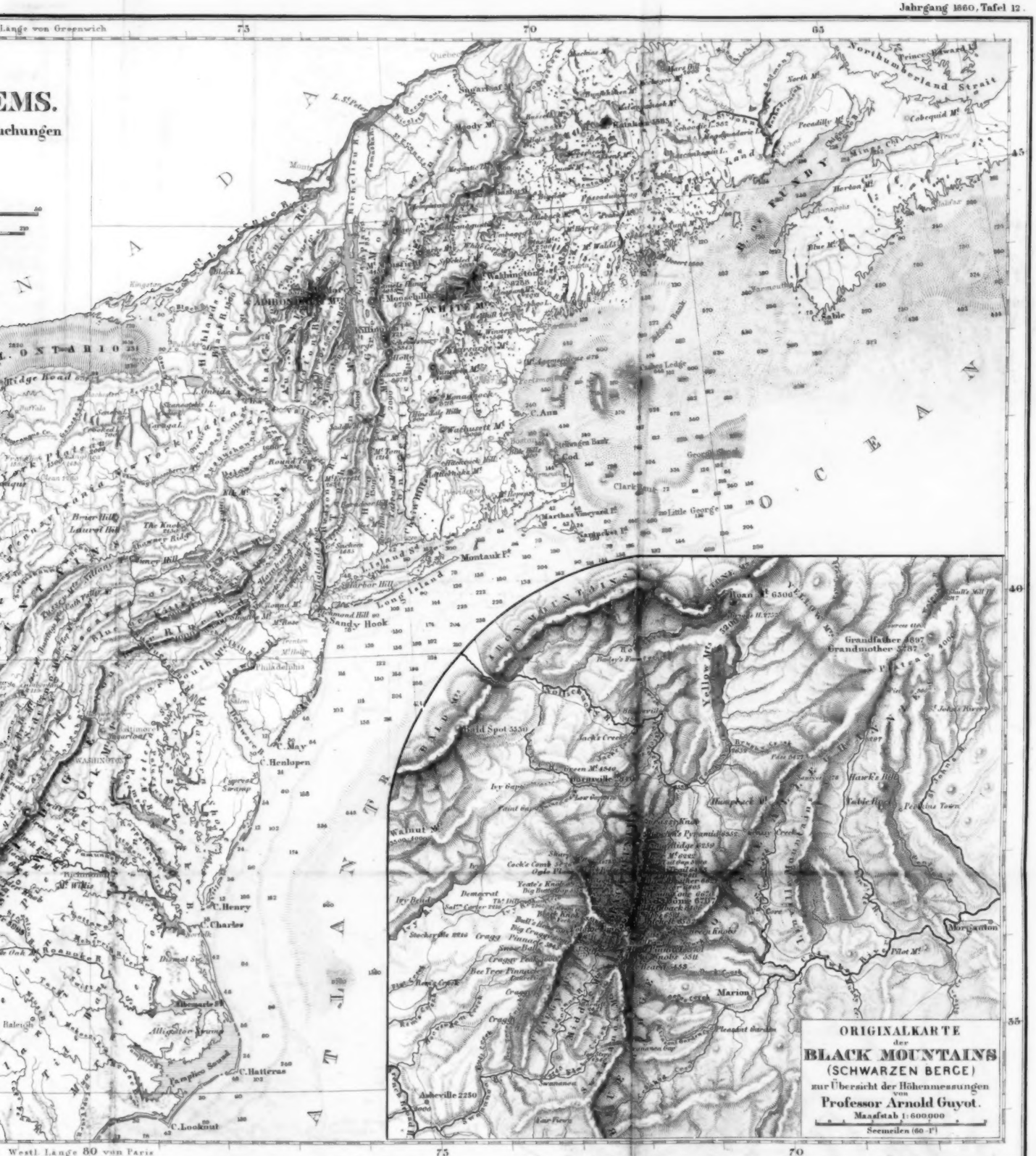


Diagram showing the deflection (in minutes of arc) of the north end of the magnet from its monthly normal position for every hour of the day and month of the year-derived from the declinometer observations at Philadelphia between 1840 & 1845

Diagram G.



A. Petermann dir



THA. JUSTUS PERTHES
1860